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Forthcoming Events.

NOVEMBER 28.

Institution of Mechanical Engineers (Sheffield Branch):—Ordinary meeting at Sheffield. "The Effect of Repetition Stresses on Steels," Paper by Professor F. C. Lea, O.B.E., D.Sc.

INSTITUTE OF BRITISH FOUNDRYMEN.

NOVEMBER 29.

Falkirk and District Branch:—Ordinary meeting at Newcastle-on-Tyne. "Sands," Paper by C. W. H. Holmes.

Newcastle-on-Tyne Branch:—Ordinary meeting at Newcastle-on-Tyne. "Drawing and its Relation to the Foundry," Paper by M. E. Gallon.

East Midland Branch:—Ordinary meeting at Leicester. "Contraction Stress, Cause, and Remedies," Paper by F. C. Edwards.

DECEMBER 6.

Scottish Branch:—Ordinary meeting at Glasgow. "Some Aspects of Foundry Costing," Paper by John Spittal.

Birmingham Branch:—Ordinary meeting at Birmingham. "Malleable Iron," Paper by D. Wilkinson.

Lancashire Branch:—Ordinary meeting at Manchester. "Spun, Cast Iron Pipes," Paper by R. A. Miles.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

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Better Castings.

There are definite signs that trade generally is improving, and it is only a *general* trade move that can influence the foundry trades taken as a whole. Railway builders and automobile foundries have been reasonably employed for some time, whilst textile and marine foundries chave been badly caught in the slump. With a revival in trade we can expect more interest being taken in recent developments. More moulding machines will be installed; obsolete cupolas will be replaced; and there will be an intensive effort to produce better castings. If there is a real boom in trade, the last phase is liable to be sacrificed on the altar of production. There is, however, the important interim period, and it is as well to examine the potentialities for the improvement of castings.

For steel castings, the two outstanding features are (1) alloy steels, about which there is an abundance of information available, and (2) heat treatment of finished castings.

For non-ferrous castings, other than light alloys, there will be, if manufacturing costs do not continue to be overshadowed by the metal account, an increase in the number of electric furnace installations, or at least a further reduction in the number of pot fires used. An extension of die casting and kindred processes is also reasonably certain, all of which make for better castings.

For grey iron castings there has been an admirable preparation during the slack period, and the numerous discussions on Lanz pearlitic cast iron has focussed public opinion in a useful direction. Better castings will be brought about by (1) controlling chemical and physical conditions of the iron; (2) by heat treating the finished castings; (3) by alloy additions; (4) by the more intensive application of oil-sand cores, of which the technique is now well understood; (5) by utilising the length of freezing ranges to better advantage; (6) by controlling sand composition conditions; (7) by the general adoption of the various methods available for the prevention of the entrance of dirt into castings; (8) by the reduction of sulphur, when thought desirable, by one of the several methods available; and (9) by the introduction of permanent moulds, where quantity is sufficient. In addition to the above, better cylindrical castings will continue to be made, with added types by the centrifugal process.

For malleable cast iron, there is every reason to anticipate metallurgical progress, in which the electric furnace will contribute its quota. With a number of brilliant exceptions, no section of the foundry industry needs a metallurgical spring cleaning more than the malleable foundry. It is a highly scientific trade, and requires all the help our metallurgists can give it.

Obviously, the production of better castings implies the installation of better and more modern plant, associated with a close chemical and physical control of all raw materials.

Most of the above conditions imply a certain reduction in the waster bill, but unless associated with greatly increased production there is likely to be an increase in cost price. It is essential that every foundry should ascertain exactly their cost of production and sell accordingly. If British foundries are to maintain their position and supply better castings they must refuse to sell on any basis which does not consider each casting as a separate entity.

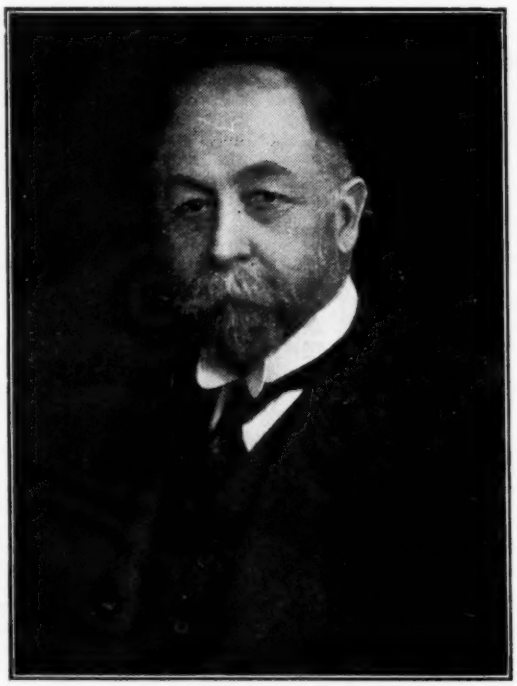
The British Cast-Iron Research Association.

ANNUAL GENERAL MEETING.

The annual general meeting of the British Cast-Iron Research Association was held in the Council Chamber of the Institution of Mechanical Engineers in London, on Wednesday, November 19. The chair was occupied by Mr. H. B. Weeks, F.I.C. (Chairman of the Council), in the absence of the retiring President, Lord Weir, who, in a letter expressing his regret that he was unable to be present, said he was engaged in the development of two highly important schemes of national interest, namely, housing and sugar, and that he found himself so tied up with these two schemes that he was forced to ask to be relieved of attending the meeting.

The position of the Association, as reflected by its annual report for the year ending June 30, 1924,* and by the speeches made at the meeting, is one calling for congratulation, and the progress which has been made during the past year is very gratifying.

Emphasising some of the matters dealt with in the Report, the Chairman touched upon the research programme which, he said, had developed very considerably. The Association had never lost sight of, and must not lose sight of, the necessity for fundamental researches in the industries associated with cast iron; they knew they had done an excellent amount of work in the way of consultation, and in the way of giving advice to the members where shop problems, etc., had arisen, and, although that sometimes led up to what they knew as fundamental research, it did not always comprise what was intended. It would be agreed that the programme of research set out in the report was very varied and very wide, and called for an enormous amount of work. Unfortunately, in connection with research, sometimes very considerable time elapsed before any real progress appeared to have been made; but, in the matters under investigation, the Association had made progress, and certainly the work promised to be of the very greatest possible interest to the industry generally. From the varied nature of the work being undertaken, a very large branch of the cast-iron industry must benefit. On the whole, said the Chairman, the Association had a very proud record for the last 12 months, and he was sure that, as time went on, the members would be pleased and proud to know that they had joined and were supporting the investigations being carried out.



SIR JOHN DEWRANCE, K.B.E.

Sir John Dewrance is the recently-elected President of the British Cast Iron Research Association. He is Chairman of Babcock & Wilcox, Limited, and of the firm of Dewrance & Company, Great Dover Street. Additionally, he presides over the Committee responsible for the research on ferrous alloys, now being carried out at the National Physical Laboratory.

The annual report and accounts were adopted by the meeting, on the proposition of MR. J. R. HYDE, seconded by MR. C. RETALLACK. The latter said that the members were delighted with the general aspect of affairs as reflected by the report and accounts, and he could say, without fear of contradiction, that the Association had made very decided strides during the year.

The question of the maximum subscription to the Association was then dealt with. The annual subscription is based upon the number of workers employed by the firms who are members, and it was indicated, at a recent meeting of the London Branch of the Institute of British Foundrymen, by Mr. J. G. Pearce (director and secretary of the Association) that he hoped to be able to fix a maximum annual subscription of £250, in order that very large undertakings, such, for instance, as railway companies, would be able to join at a reasonable subscription. Accordingly, MR. J. CAMERON (Senior Vice-President of the Institute of British Foundrymen) moved a resolution that the maximum annual subscription should be £250. This was seconded by MR. J. T. GOODWIN, who said that, whilst the figure appeared to be rather large for one firm to pay for the information received from the Association, he could assure the members that it was not large when they considered the amount of work the Association was doing, and the very wide programme it had before it in the future. After serious discussion, the Council had considered, on the whole, that the figure of £250, as a maximum annual subscription, was as low as they ought to go. There was no doubt that in the near future it would be felt that the small subscriptions being made did not meet anything like the amount of data and valuable information that would be forthcoming. It required time before fundamental research could become definite information; during that time a great deal of heavy work had to be done, and the Association wanted to safeguard itself over that period.

The resolution was carried.

The New President.

The CHAIRMAN then proposed that Sir John Dewrance, K.B.E., be elected President of the Association, in succession to Lord Weir. There had been difficulty, he said, in getting Sir John to consent, because he was one of those who did not like to associate himself with such a body if he were not sure that he could give sufficient time to it. However, as the result of the persuasive efforts of the Director and Secretary, Sir John had at last succumbed. It was in the interests of the Association in every way that Sir John should be President. They all knew his reputation as an engineer; also, he was keenly interested in research work, and the Chairman was quite sure that, under the presidency of Sir John, the Association would progress very rapidly and satisfactorily.

MR. N. B. ELLINGTON seconded, and the resolution was carried unanimously.

Election of Vice-Presidents.

Mr. G. Pate, O.B.E., J.P. (Falkirk), Mr. Summers Hunter, C.B.E., M.Inst.C.E. (Wallsend-on-Tyne), Mr. F. W. Firth (Sheffield), Mr.. C. E. Lloyd, O.B.E., M.P. (Dudley), and Mr. W. B. M. Jackson (Chesterfield) were elected vice-presidents in place of Mr. H. Deacon, M.Inst.C.E., Vice-Admiral Sir George Goodwin, K.C.B., Mr. A. Laing, C.B.E., Mr. P. W. Petter, J.P., M.I.Mech.E., and Mr. Douglas Vickers, J.P., who retired automatically.

* See last week's FOUNDRY TRADE JOURNAL.

Re-election of Vice-Presidents.

Commander C. W. Craven, O.B.E., R.N. (Barrow), and Prof. T. Turner, M.Sc. (Birmingham), were re-elected vice-presidents for a further year.

Vote of Thanks to Lord Weir.

MR. J. T. GOODWIN proposed a vote of thanks to Lord Weir for his services as President since the inception of the Association, and that, as a recognition of his services, his Lordship be elected an honorary member. The Council felt grateful, he said, for the good work Lord Weir had done, and his valuable assistance at the inception of the Association was such as to put it practically in its feet, and afterwards, when difficulties had arisen, through no fault of the Association, his services had been of great value.

MR. W. B. PARKER seconded, and added his testimony as to the valuable assistance given by Lord Weir at the time of the formation of the Association.

The CHAIRMAN also emphasised the value of the assistance given by Lord Weir, and how much the Association was indebted to him for the manner in which he had stuck to it so long as the Articles of Association would allow. They parted with him with very great regret.

The vote of thanks was accorded with acclamation.

Thanks to Retiring Vice-Presidents.

A vote of thanks was then accorded the retiring vice-presidents for their services during the past three years, and, in order that they might be able to retain their interest in the Association, they were elected members of the Membership Committee.

Re-election of Members of Council.

Mr. A. J. Burn, Mr. F. J. Cook, Mr. T. Donaldson, Mr. N. B. Ellington, Mr. J. Haigh, Major C. Howl and Mr. M. Riddell were re-elected members of Council.

Thanks to Retiring Members of Council.

A vote of thanks was accorded to Mr. E. Adamson and Mr. T. F. Hardyman for their past services on the Council. They did not seek re-election.

Honorary Members.

On the motion of MR. W. H. WHITEHOUSE, seconded by MR. H. C. BUCKMASTER, Dr. W. Rosenhain, F.R.S. (National Physical Laboratory), and Prof. T. Turner were unanimously elected honorary members of the Association. It was stated by the Chairman that the Council would feel honoured by the acceptance of the positions offered, it was the least, and the most, that the Association could do in recognition of the work done by the gentlemen in question, and which it was hoped they would still continue to do, especially in connection with cast iron.

DR. WALTER ROSENHAIN, F.R.S., expressing his thanks, said that the programme of research which the Association had developed was one of very considerable interest in many directions, and he was particularly pleased that it did not in any degree overlap with the work undertaken, from a rather different viewpoint, at the National Physical Laboratory. He hoped that in the future it would be possible, not only to continue to support the Association had already given to that research, but to bring about co-ordination and collaboration to a considerably higher degree than had been the case in the past.

Delegate Members.

The following were elected delegate members:—Institute Electrical Engineers: Mr. E. B. Wedmore; Institute Automobile Engineers: Dr. W. H. Hatfield; National Ironfounding Employers' Association: Mr. D. Brown, J.P.; Birmingham Metallurgical Society, Dr. L. Aitchison; Institute British Foundrymen: Mr. H. Field; Iron and Steel Institute: Prof. T. Turner, M.Sc.; Institute Mechanical Engineers: Mr. H. Livesey; together with a delegate from the Staffs. Iron and Steel Institute.

Votes of thanks were then accorded to Prof. T. Turner, Prof. C. H. Desch, Prof. F. C. Thompson, Mr. W. J. Rees and Prof. P. G. H. Boswell, Scientific Advisers to the Association; to the Council for their services during the past year; and to the Chairman for having presided at the meeting.

MR. J. T. GOODWIN, who seconded the vote of thanks to the Chairman, paid a tribute to him for his work, and said that, had it not been for Mr. Weeks, during the first two years of the Association's existence at least, it would not have been in being to-day. Whereas the Association was looked upon unfavourably by the Department of Scientific and Industrial Research at one time, as the result of the valuable work of Mr. Weeks and of Mr. Pearce the Association was now looked upon by the Department as one of the most pre-eminent Associations at work in the country. That change was very gratifying.

The meeting then closed.

Cleveland Institution of Engineers.

Opening the sixty-first session of the Cleveland Institution of Engineers in the Technical Institute, Middlesbrough, on Monday night, the PRESIDENT (MR. H. B. TOY) expressed his appreciation of the confidence shown by the members in re-electing him for the second year to preside over their meetings. Proceeding, he went on to urge the desirability of a University for the district, so that they might be equal to Birmingham, Sheffield, Leeds, Manchester, Newcastle and Glasgow. He hoped that by the united efforts of the various technical and scientific organisations the time would not be far distant when the foundation would be laid of an Institution which would be a credit to the town.

The report of the sixtieth session, presented by MR. W. H. BURNS (Secretary), recorded that there were at the beginning of the session 408 ordinary members, but they had since been reduced to 381. There were, however, 12 new members elected on Monday night.

The retiring members of the Council—Messrs. Cyril Pease, E. W. Jackson and Jas. B. Peat—were re-elected with the addition of Messrs. Wm. A. Lyons and John A. Thornton. In place of Mr. Frankland, resigned, Mr. E. Cowell was elected auditor.

The balance-sheet, showing an income of £805 and a surplus of £74, with £156 cash in hand, was adopted, and a vote of thanks was accorded to the President for his services during the year.

Cast Iron of Pearlitic Structure.

Considerable interest has been aroused in this country by British Patent Specification No. 147933 by A. Diefenthaler.

The occurrence of pearlite in all cast iron and the general conditions necessary for the production in cast iron of a structure of pearlite have been known for many years, but the specification gives particular temperatures for heating dry-sand moulds for iron castings of specified thickness and composition. Thus a composition of 3 per cent. total carbon is recommended, of which 0.85 per cent. is combined, together with 1 per cent. silicon, 0.7 per cent. manganese, 0.4 per cent. phosphorus, and 0.1 per cent. sulphur, and for this moulds require preheating to 390 deg. F. for a thickness of 0.4 in., or 300 deg. F. for 0.8 in., or 210 deg. F. for 1.2 in.—"B.C.I.R.A. Bulletin."

Foundry Query.

Coal Dust and Mould Skin.—*No.* 431, *page* 436.

I would advise "Silica" to try "best hard" from the Newstead Colliery Company, Notts.—J. H. LIST.

DR. S. Z. DE FERRANTI has just returned to England after an extensive tour of the United States and Canada. At the conclusion of the tour on November 6, a luncheon was held at the Yale Club, New York, in honour of Dr. Ferranti, and was inaugurated by the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, and the American Institute of Electrical Engineers.

XUM

The Electric Furnace in the Pipe Foundry.*

BY JAMES T. MACKENZIE.

The situation in the American cast-iron pipe industry at the beginning of 1919 was very uncertain. The Government had suddenly withdrawn from the market, and other consumers were loath to buy at the prices obtaining at the time. In considering the situation it seemed necessary to reduce the cost to the consumer, and this could be best accomplished by reducing the metal thickness of the pipe which called for an equivalent increase in the strength of the metal. The saving which could be effected was not only the actual cost of the metal in the foundry but the considerable reduction in freight which was in many cases one-third of the cost to the consumer.

Scrap Steel Used to Increase Strength.

To increase the strength of the metal it was necessary to increase the percentage of scrap in the mixture, especially steel scrap, which had the additional advantage of some £2 per ton in price and was available in large quantities. Other scrap, such as car wheels, stove plate, etc., was also available if means could be found to employ it satisfactorily. The electric furnace had come prominently to the front as a means of converting low grade materials into a satisfactory product and it was decided to install one. This seemed to offer a solution to the problem of using direct blast-furnace metal which had previously been tried and abandoned on account of the difficulty of keeping it hot enough for the work. A mixture of cupola-melted scrap with direct metal was especially attractive, as there would be no deterioration of that portion of the mixture used direct and no melting cost to add to the price. The electric furnace offered itself as a deoxidiser for the cupola metal and as an effective superheater for the direct metal or the mixture of the two.

The American Cast Iron Pipe Company installed a 6-ton Ludlum furnace and began operations with it on June 1, 1919, running on an acid bottom. For the first month the operation was simple superheating of cupola iron carrying high percentages of scrap including some 15 per cent. to 30 per cent. steel. This was held for ten or fifteen minutes in the furnace under a cover of cupola slag and a little coke breeze, which was usually long enough to give the slag a dark green colour and the metal a temperature rather higher than was necessary. This operation was quite satisfactory, giving an iron of fairly good casting properties and high strength, the standard 2 x 1 x 26-in. bar averaging about 2,600 lbs. with a deflection of about 0.40 in.

Direct Metal Tried Out.

Direct metal from a nearby furnace was introduced on July 1 using small hemispherical pots of 15 to 20 tons capacity. It can readily be seen that this metal of approximately 3.0 per cent. silicon, 0.03 per cent. sulphur, and 0.5 to 1.0 per cent. manganese used without the losses sustained in passing through the cupola (which are higher when much steel is used) would allow the use of very high percentages of scrap in the cupola when used in the proportion of two parts direct to three parts cupola iron. The mixture was given about 20 minutes' treatment, which was ample for deoxidation and superheating.

This operation was continued until June, 1920. There were several conditions acting against its continuance. The care and upkeep of the pots were more expensive than had been anticipated. Stock conditions at the blast furnace were not good, and the metal was varying too much from cast to cast. Stocks at the local scrap yards were inadequate to enable one to keep the correct proportion of cupola metal to direct metal. The foundry was being forced to an excess of steel scrap in order to get low silicon cupola metal where we had been able to get low silicon cast scrap sufficient for the purpose when we started. This lowered the carbon too much, especially on the high silicon pots where the carbon was already low in the direct metal. The slightest mishap in cupola operation on these high steel mixtures further aggravated the condition.

Segregation of Manganese-Sulphide Causes Trouble.

The furnace was then put on a normal grey iron mixture running about 1.8 per cent. Si, 0.08 per cent. S, 0.4 per cent. Mn, 0.7 per cent. P, and 3.5 per cent. C. Cold steel was added to the cupola metal in the furnace sufficient to reduce the carbon about 0.2 per cent. This took a little more time but was much more satisfactory and easy to work. There was quite a bit of trouble from the high freezing point of this iron. It had to be poured at 50 or 100 deg. C. above that of the normal cupola iron, and if it was too hot there was trouble with cutting of the moulds and cores and with segregation of manganese-sulphide in the top of the casting. Adding ferro-phosphorus to restore the fluidity was tried, but with no appreciable results. Raising the manganese was also tried, but the segregation increased.

To overcome this the furnace was changed to basic bottom in December, 1920, resuming operations about January 1, 1921. The furnace was given the iron from only one cupola which was run on a high scrap mix of approximately 1.3 per cent. Si, 0.10 per cent. S, 0.3 per cent. Mn, 0.6 per cent. P, and 3.2 per cent. C, in the ladle. One ladle (3½ tons) of cupola iron was charged, the current turned on, and slag materials added. By the time the next ladle was ready to go in, the slag was fluid and sulphur reduction had begun. The current was not interrupted for the addition of the second ladle, so by the time the third ladle from the cupola was ready the furnace was ready to tap, alloy additions having been made some three to five minutes previously. Sulphur reductions averaged about 0.04 per cent.—bringing the metal down to about 0.06 per cent.

Re-carburising to Increase Pouring Range.

The pouring range was still too narrow; in fact, the sulphur reduction did not seem to help much so re-carburising, first in the furnace with coke breeze and green poles was tried, and then with blacking in the ladle. Poling was very unreliable and quite expensive, but the blacking gave a very good recovery of some 0.2 per cent. carbon from 0.5 per cent. charged. This widened the pouring range somewhat, but it was still too high, so after trying silicons up to 2.5 per cent., sulphurs down to 0.03 per cent., and manganese all the way from 0.3 per cent. to 1.2 per cent. without material relief, the scrap mixture was completely abandoned and simple deoxidising and desulphurising of the regular mix was tried. The pouring temperature was still very distinctly higher after treatment than before, though it was entirely possible to make remarkably tough metal with this simple treatment, 4-in. standard class "B" pipe being almost unbreakable with an 8-lb. hammer and the test bar giving nearly 3,000 lbs. transverse strength with a deflection of nearly 0.5 in. This operation could undoubtedly have been worked out very satisfactorily, but by this time, March 1921, the price of pig had gone down so much more than scrap that the differential was not sufficient to cover the cost of operating the furnace, so after due consideration the furnace was shut down on April 1, 1921.

* A Paper presented to the Milwaukee Meeting of the American Foundrymen's Association. The Author is connected with the American Cast Iron Pipe Company.

Threatened Iron and Steel Workers' Strike in Belgium.—Delegates of the Belgian iron and steel works and shipyards this week, in view of the refusal of the employers to grant an increase in wages on account of dearer living, instructed their executive to organise a strike in certain works to be selected by a special commission after a statutory referendum.

Iron Ore Reserves in the United States.—MR. OLIN R. KUHN, writing in "The Iron Age" on the "Iron Ore Available for United States," points out that, assuming that the production of pig-iron increases during the next ten years at the rate of 1,000,000 tons annually—the increase over the last 30 years has averaged between 1,000,000 and 1,500,000 tons per year—and thereafter at half this rate, or 500,000 tons annually, the United States will consume over 12,000 million tons of iron ore over the next 100 years. According to these calculations the reserve ore available for consumption by the country will become depleted in about 120 years, and the potential reserve of low-grade ores will last another 135 years. Thus there is little danger of any serious shortage of iron ore in the States for 250 years or more.

General Cupola Design and Practice.*

By A. Campion, F.I.C.

The foundry cupola in all probability represents the simplest form of melting apparatus in general use for large-scale operations; essentially it is simply a vertical cylinder with holes at the bottom for admitting the air necessary for the combustion of the fuel, and others for withdrawing the metal and slag. There may or may not be a door near the top through which coke, iron and flux are charged.

The cupola is remarkable inasmuch as in its essential form it has undergone practically no alteration, and remains in very nearly its original form. Certainly changes have been made from time to time, but it is curious how temporary they have been. The only important modifications which have had any degree of permanence are: —(1) Increased height, giving a greater length of stack above the tuyeres; (2) the addition of a reservoir or belt through which the air is distributed to the tuyeres instead of direct connection of air pipe to tuyeres; (3) reduction of the internal diameter between the furnace bottom and the tuyere level; (4) drop bottoms; (5) metal receivers, whilst many alterations have been made as regards shape, size, number and arrangement of the tuyeres placed in one, two or three rows at various distances from the bottom.

The main object of the various designs and arrangement of tuyeres is the better distribution of the air within the combustion zone.

In melting iron for foundry purposes the cupola occupies the premier position, and its behaviour and management determines to a very large extent the general success of the foundry work. The objective in successful operation of the cupola is to provide a supply of molten metal as rapidly or as regularly as possible suitable for the work in hand, or, in other words, to secure the maximum efficiency.

Efficiency—What is It?

One often hears of thermal efficiency or the proportion of the heat units in the fuel usefully employed within the furnace itself, but the term cupola efficiency means something more than this. It involves a consideration of the questions of arrangement and construction of plant so that the combustion of the fuel shall be as complete as possible, that the heat produced from the fuel shall be as completely as possible absorbed or utilised within the furnace, or, to put it another way, the coke consumption shall be at a minimum and the quantiy of heat and the temperature produced in the melting zone at a maximum, so that the greatest possible weight of metal per unit of capacity shall be melted and superheated to casting condition. We may therefore define cupola efficiency as meaning the production of the greatest quantity of molten metal suited for the work in hand, with the lowest consumption of fuel, in the shortest time and at lowest cost. It is quite possible to produce metal at a low cost, but not suitable for the job; that is not efficient working.

Requirements for Efficient Working.

1. To attain a temperature sufficiently high to melt and superheat the metal to such an extent as to enable the mould to be filled and casting completely run whilst metal is completely fluid and without separation of the constituents to allow of regular solidification and cooling.

2. To generate sufficient heat to melt and superheat to the desired limit with least possible consumption of fuel. The minimum heat required is a perfectly definite quantity for each quality or mixture of metal. It depends on the melting point, specific heat, and latent heat of the metal.

3. The combustion of a certain amount of fuel to generate the heat under second requirement. It must be remembered in this connection that a given fuel can only generate a certain quantity of heat per unit of weight, and this amount is governed by the composition of the fuel. Whether this quantity is obtained or not depends upon how the fuel is burnt, that is to say how completely, whilst the effect or result of generating this quantity is influenced by the rapidity of burning, the quantity and manner of application of the air, the extent of the space in which it is burnt, and the arrangements for transmitting the heat to the metal being melted.

4. *Effective Utilisation of the Heat Generated.* —This depends a good deal on the construction and arrangement of the furnace—*i.e.*, position of the combustion zone, the arrangement of the charges, concentration of heat, etc. In ordinary circumstances heat is only transferred or communicated from one body to another by direct contact or by radiation. Gases heat by contact only; they have very little radiating power. In cupola working, heating is effected by:—(*a*) Direct contact with incandescent coke; (*b*) radiation from the exposed surface of incandescent coke (if two pieces of incandescent coke are one behind the other, metal is only effected by radiation of surface of coke facing it); and (*c*) by heat from hot gases by direct contact. This accounts for the largest part of the heat of fuel actually transferred to the metal. The greatest proportion of the heat generated is first taken up by the gases and by them distributed through the furnace. The final product of burning fuel is gaseous, consequently it is of supreme importance to give attention to all factors which influence the manner of distribution or completeness and regularity of contact of the gases with the solid material in the furnace, as these affect the furnace working; if the distribution is bad or irregular, there results irregularity of contact with non-uniform heating, the gases pass away at too high a temperature, and this means waste of heat and inefficiency, and if the gases are insufficiently cooled the zone of maximum temperature rises in the furnace generally or locally.

Cupola Design.

In designing the cupola for certain specified duty it is necessary that careful consideration be given to a number of vital factors:—The size necessary to secure a specified output under conditions—*i.e.*, the diameter at the tuyere level, the number, size, shape and arrangement of the tuyeres; the height from tuyere level to sill of charging door; the relative capacities of wind belt and air-blast pipe; the quantity of air necessary, and the manner in which it is to be delivered to the furnace.

The literature of the subject shows that great diversity of opinion exists as to the relation and proportions of the various parts of the cupola, conditions of blast and fuel consumption, statements by different writers vary so greatly, and in some cases appear so extraordinary that one wonders whether the authors have had closer acquaintance with cupola practice than as travellers for pig-iron or electric wiremen.

It is much to be desired that some rational system of designing cupolas should be established similar to the method of designing an open-hearth steel melting furnace, based upon well-defined data. It is not uncommon for a founder desiring to erect a new cupola to decide the size of his furnace according to what someone has told him ought to give a certain output. The blower, pipes and connections are of indefinite capacity and size, and the tuyeres are of more or less fantastic shape and arrangement. The furnace is lighted and the blower speeded up until a pressure gauge indicates so many inches, ounces or pounds, because some other foundry use a similar pressure and obtain fair results, and no account is taken of the conditions and requirements in the other foundry, which may be entirely different. There is absolutely no attempt to work upon known or ascertainable data or to develop a system of maximum efficiency.

In designing a cupola, the following facts and relationships must be carefully considered :—

* Paper read before the Birmingham Branch of the Institute of British Foundrymen, Mr. T. Vickers presiding.

XUM

(1) The sectional area at the melting zone determines the quantity of fuel which can be burnt in a unit of time on one plane, and consequently the melting capacity of the furnace. It is therefore very important that the size of the furnace should be stated in terms of the melting zone inside the lining, and not of the stack or external diameter as is often done.

(2) The quantity of metal it is desired to melt determines the amount of fuel which has to be burnt in order to give the necessary quantity of heat after due allowances for losses. The principal directions in which heat is lost or utilised in other ways than melting and superheating the iron are:—Formation and melting of slag; radiation: heating the furnace, and escaping as sensible and latent heat in the gases.

(3) The weight of coke which has to be combusted determines the amount of air at a given density which has to be supplied to the furnace.

(4) The quantity of air required determines the area of the tuyeres necessary to convey the air at suitable velocity. The total tuyere air must be adjusted according to the number and shape of the openings to allow for frictional effect upon the velocity.

(5) The tuyere capacity determines the size of the air pipe or conduit necessary for the conveyance of the requisite quantity of air from the blower to the wind belt and also the size of blower.

If the design is based upon these facts it should be possible to obtain reliable data for the establishment of a rational system of cupola construction similar to that adopted in the steel industry.

There must be a proper proportion and relationship between all parts of the cupola, and not, as is so frequently the case, only the relative area of furnace and tuyeres considered.

In deciding upon the total area of the tuyeres, it is necessary to take into account the amount of air which is to be introduced at a certain velocity, the penetration factor, and the distribution of the air within the furnace. The latter very largely influences the number and disposition of the individual tuyeres. The question of friction comes in as a factor controlling tuyere area, and this depends upon the shape. The volume passed by tuyeres of equal area but different shape varies with the friction encountered.

If p = pressure, a = area in square feet, S = the area of surface, V = velocity, and K = coefficient of friction

$$pa = KSV^2.$$

The friction varies with the size of the bounding surface. For instance, tuyeres of 12 × 4 and 8 × 6 give the same area, but the area of surface is different, and the amount of air passed will be in the ratio 1.15 : 1.0. The most successful shape of tuyere appears to be oblong, with the horizontal width about 1.2 to 1.25 times that of the height. Tuyeres of this shape offer a minimum frictional resistance to the air and keep clear throughout even long melts when the area is properly adjusted to the size of the furnace, and pressure and velocity of blast such as to give suitable penetration value.

The most economical working is obtained when the amount of air required passes through the tuyere at the rate of 400 cub. ft. per min. for each square foot of sectional area of cupola bore at melting zone.

As the relative velocity can be ascertained of air forced through an orifice at a given pressure, the penetration factor can be calculated.

$$\frac{WV^2}{D}$$

Where D = cupola diameter, V = velocity per sec., and W = weight of air passing per sec.

The ratio of cupola area to total tuyere area should vary with the size of the furnace at melting zone.

In cupolas up to 40 or 42 in. diameter the ratio should be 1: 4 or 1: 4.5; those having diameters between 40 and 63 in. the ratio should be 1: 4.5 to 1: 5.5, and in large cupolas 64 to 90 in. diameter the ratio may be 1: 5.5 to 1: 7.0.

The area of the blast pipe conveying the air from the blower to the furnace must bear a definite relationship to the tuyere area. It must be emphasised that the blast from a single main cannot with the same power be discharged at the same rate through a number of tuyeres having a total area equal to the area of the main, because in dividing the volume between a number of openings there is involved a loss due to friction. The total tuyere area must therefore be greater than the sectional area of the blast pipe.

The ratio of blast-pipe area to total tuyere area should be for cupolas up to 42-in. dia. 1: 1.6 to 1: 1.75; cupolas between 42 and 63 in. dia., 1: 1.4 to 1: 1.6, and for larger ones 1: 1.4 to 1: 1.1.

The wind belt should also bear a relationship to the blast pipe. The general practice is to make the belt too small, and in some cases the advantages of ample tuyere area are neutralised by this means. A large belt gives steadiness of blast entering the furnace by acting as a reservoir and minimising the effect of pulsations where a positive blower is used, and at the same time allows of the blast being equally divided between the tuyeres.

The ratio of sectional area of wind belt to that of the blast main should not be less than 3:1, and may be 3.5:1 or 4:1 in large cupolas. The belt may be placed so as to be inside the shell, in order to permit of warming the blast, whereby considerable benefit is derived, not so much from a saving of coke between charges—which is small at the best—but the chilling effect of the air as it enters is reduced, and a better distribution of heat is obtained.

The height of the cupola between tuyere level and sill of charging door is important. It is relatively greater in large than in small cupolas, as the melting zone inclines to rise higher, owing to the necessarily increased pressure. In small cupolas the height may be from 3 to 4½ times the diameter, 2¾ to 3½ in medium, and 2½ to 2¾ in very large ones. It may also be equal to 24√ diameter for all sizes.

These heights are given on the assumption that the tuyeres will be placed 16 in. to 20 in. from the bottom of the furnace.

Cupola Output.

This will vary to some extent with the nature of the metal, the size of scrap, etc., but with a furnace of properly balanced proportion in all parts and properly adjusted air supply, travelling through the tuyeres at approximately 30 ft. per sec., there should be melted 16 to 17 cwts. per hour per sq. ft. of cupola area. This corresponds to the most economical rate of coke burning of 180 lbs. per sq. ft. per hour, and requires 25,000 cub. ft. air per hour. It is usual to state the air requirement as so much per ton of metal melted, but this is, in the opinion of the writer, to be discountenanced. The air is for the purpose of burning coke to produce the necessary heat, and the air supply should therefore be stated in terms of coke. The usual 30,000 to 33,000 cub. ft. of air stated to be necessary to melt a ton of iron is only correct when 2 to 2½ cwts. of coke per ton between charges is used. Many foundries work with less, and unfortunately some use considerably more. The volume of air required for different coke consumption is shown in Table I.

TABLE I.—*Volume of Air necessary for Various Melting Ratios.*

Coke per ton of Iron melted. lbs.	Cubic feet of air.	Melting ratio.
224	32,000	1—10
200	28,000	1—11.2
196	27,500	1—11.4
180	25,200	1—12.4
168	23,520	1—13.3
160	22,400	1—14.0

The weight of coke has reference to that placed between charges and exclusive of the bed.

The volume of air should be weighed or measured. This has presented some difficulty in the past owing to suitable instruments being either too costly or too liable to get out of order under foundry conditions. An instrument can now be obtained at a moderate outlay which is at the same time accurate, robust and fool-proof. If cupola men scrapped ordinary pressure gauges and installed volume gauges there would be a greater average cupola efficiency obtained than is now the case.

Charging the Cupola.

The filling of the cupola should commence so soon as the bed is well alight and the brickwork warmed up. The practice of burning for hours with the doors and tuyeres open before charging is very wasteful, and not conducive to the best melting. The bed, although requiring to be well lighted, must not be over-burned.

The best practice would appear to be to fill up with coke to the tuyere level, and when well lighted the tuyere doors should be closed, then more coke added to bring the bed the requisite distance above the tuyeres. Charging of the cupola should then proceed. The weight of metal per charge will depend upon the class of iron melted and also the size of the scrap, but light charges are to be preferred to heavy ones provided they are sufficient to give a good covering in each layer. The pig is better placed rather more to the centre, but not to such an extent as to have a central pile of metal surrounded by coke. The ideal arrangement for fast and efficient melting would be for the coke to be arranged in the form of a sort of basin with sides and bottom of equal thickness, to counteract the tendency for the air to travel up the sides of the furnace more readily than the centre, and also to ensure that the blast always impinged on coke. This ideal is not possible in practice, but it can be approached by placing a little more coke to the circumference than the rest of the cupola area. It is essential that there should be a layer of coke over the whole area between each charge of metal, of a depth suitable to the tuyere arrangement; it averages about 5 in., but varies with local conditions. Weighing does not always secure the best depth owing to variations in density of the coke—that is, a heavy coke made with the usual weight gives too shallow a layer. To overcome this it is recommended that when once the best depth of coke charge has been found for a particular furnace, a sheet-iron ring be made of that depth and with a diameter equal to that of the cupola at the tuyere level. This should be filled with coke and the weight determined; in this way a constant depth can be maintained with different cokes.

The practice of putting on the blast for a short time after a few charges have been filled in is not to be commended; when the coke is called upon to give up its heat, it should do so quickly, and the heat should be concentrated in the melting zone for the purpose of transference to and melting of the metal.

Heat Development and Melting.

This depends principally upon the completeness of the combustion of the fuel. Carbon burns in two stages—to carbon monoxide and carbon dioxide, the latter reaction producing the maximum heat. To secure this it is essential that a sufficiency of oxygen be brought in contact with the carbon. Increased temperature results from concentration of heat, and this in turn increases efficiency. A certain quantity of fuel is necessary to generate enough heat to raise the iron to the lowest temperature at which it can become liquid, and a further amount to increase the temperature of metal and slag to give the desired fluidity. The greater the concentration of heat from burning the fuel, the hotter and more fluid the metal; the density of the coke affects this to some extent, but is mainly influenced by the quantity of air and the manner of its admission; that is to say, the pressure and velocity of the air supply and the surface of the fuel exposed to the blast.

Theoretically, if all the heat from 1 lb. carbon burnt to carbon dioxide was applied to the metal, about 47 lbs. could be melted, or 1 lb. of average coke should melt about 40 lbs. of iron, but there are losses, and it has to be remembered that foundry metal must be raised considerably above the melting-point. The bed coke introduces a disturbing element into the calculations, as it varies so much in different furnaces, some requiring deep beds, others shallow ones. The only proper method of stating coke consumption is to give the fuel ratio so as to show the bed, and charge coke separately. In many foundries a ratio of 1:10 is considered very good; it is not only possible to do very much better, but ratios of 1:14 or more are obtained regularly in many foundries.

The fuel and metal being arranged in position, it requires to be supplied with the appropriate quantity of air for combustion, and although the actual volume or weight can be determined, it may be introduced so that it only just keeps combustion going, or at quicker rates, up to the maximum at which oxygen and carbon are capable of combining. The latter limit is largely determined by the area of the fuel which can be presented to the blast. The actual surface area of the coke in a given space which can be brought in contact is limited by the area of the cupola and the surface area of the pieces of coke. There is a particular rate at which air must be applied in order to obtain the maximum speed of combustion.

The area of coke that would be presented to the blast could be easily calculated if it were a solid mass with plane surfaces, but a mass of coke pieces, interspersed with pieces of metal, is quite a different matter, particularly so because an increase of pressure not only supplies more air to the surfaces of first contact, but also causes penetration of air to higher planes in the coke mass, thus increasing the surface of contact. The size of the pieces of coke and the structure of the coke are also variable factors, so that the best rate of air supply must be finally adjusted by practical trial.

It therefore becomes necessary to consider not only the actual amount of the air supply, but the manner of its application to, and distribution through, the plane of its introduction into the cupola.

The velocity of the air entering the furnace is of itself indicative of nothing, it is only one factor in determining the quantity of air entering. When a given amount of air is passed through tuyeres it comes in contact with a mass of lighted coke, through which it can only penetrate by tortuous routes in all directions. The tendency is to travel upwards more readily than inwards, owing to the absence of outlets except upwards. The area of effective contact takes the form of an inverted cone; although the supply of air and the most active combustion may not extend quite as far upward in the centre as at the periphery, and there may be an appearance of a slower velocity of air in the centre, it is more than probable that the quantity in the centre is not very different from that at the periphery (currents from all the tuyeres converge to the centre).

In a plane a little above the tuyeres melting takes place all over it, but the zone of highest temperature tends to come nearer the lining the higher up; as distance from the tuyeres is traversed, the space for expansion becomes larger.

Velocity or rate of entry is then by itself of little or no significance in determining air quantity, but it is a factor in determining the distribution of the air within a lighted cupola.

In the case of an unlighted cupola, air would travel to the same extent inwards for any velocity multiplied by tuyere area, giving the same quantity of air per unit of time. The course of the current is broken by the pieces of coke, and once within the cupola, the pressure as a factor becomes absorbed in the resultant or quantity and loses its identity; but after the coke is lighted, the cutting action of high velocity and small current would be more noticeable than low velocity and large current, and would have a greater chilling effect at entrance by impinging the same quantity of cold air on a smaller area; consequently it is very important to determine the lowest velocity capable of penetrating to the centre. There is such a minimum velocity, at which it is desirable to introduce the proper quantity of air for each cupola.

If the lighted coke in a given plane zone through the bosh is supplied with an increasing quantity of air, there is reached a maximum quantity which can combine in a given time in that zone, and if the quantity be further increased the excess passes to a higher zone, or, in effect, increases the depth of the zone of combustion, but this cannot go on indefinitely if the air is introduced from the same point, for once the maximum rate of combination of oxygen and car-

bon is reached, any excess has to pass through the zone in which action is going on, and only serves to dissipate the heat of combustion to a higher zone.

As the quantity introduced in one plane increasingly exceeds that needed for the maximum possible combustion, effective melting is reduced and a certain chilling area is created through which metal has to pass, and there is also the possibility of oxidation and burning of the metal. To remedy such a state of matters it is the common practice to reduce the air supply without redistributing it, which is effective if the supply is really excessive, but bad practice if the excess of air is only local, as the correct remedy in that case is redistribution of the supply.

It comes to this, then, that there is a maximum quantity of air which can be introduced at one level, and that is the quantity to give the maximum combustion in that zone or level. If it is desired to increase the depth of the melting zone, the excess of air should be introduced at a higher level, *i.e.*, just above the hottest part of the original zone. If it be introduced too high, it only serves to increase the waste and increases the proportion of carbon monoxide in the waste gases.

A careful study of the above facts will probably assist in explaining some of the conflicting opinions expressed by cupola men as to the value of one, two or three rows of tuyeres.

Mr. Cook has given certain formulæ for calculating the maximum air supply and successful melting capacity of cupolas, in which the factors quantity of air and pressure of blast assume prime importance.

The rate at which oxygen is brought into contact with the coke determines the rate of combustion for any particular diameter of cupola.

A single row of tuyeres should give the best, most regular, and economical working if all parts of the furnace are properly proportioned and the quantity, pressure and velocity of blast are properly adjusted.

Sometimes a second row of tuyeres gives quicker melting by increasing the depth of the melting zone, but to ensure this it is necessary to know the velocity and quantity of air to give the highest possible rate of combustion with one row of tuyeres, and the second row must be so placed that the air injected through them shall act just below the top and less active portion of the combustion zone set up by the lower row of tuyeres.

Introducing a secondary supply at a point too high to effectively extend the zone is bad and wasteful. If, however, the combustion set up by the first row is below the maximum, the introduction of air at a higher point is advantageous, as it offers a certain amount of resistance to the upward passage of the lower current, giving it longer contact and more opportunity to combine with carbon in its own zone, and at the same time setting up active combustion in the higher plane in such a manner that it merges into the lower one.

In practice, a third row of tuyeres is not effective, as it stands too high and only results in an increased production of carbon monoxide. The useful extension of the zone of combustion is limited by the quantity of the products of combustion. It has to be remembered that 79 per cent. of the air blown in is nitrogen, and this, together with the carbon dioxide formed, causes sufficient dilution to prevent further useful combustion going on.

It has been stated by several writers that a second or third row of tuyeres is useful as a means of securing more complete combustion, by supplying air to unite with the carbon monoxide passing upwards from the bottom row; this, however, is a fallacy, as the temperature is above the dissociation point of carbon dioxide especially in presence of excess carbon. It is extremely doubtful whether additional rows of tuyeres in any way effect the completion of combustion to carbon dioxide. It seems much more probable that they would cause an increase in the carbon monoxide unless placed in the exact position necessary to extend the zone of combustion.

The combustion of the escaping gases gives some useful information as to the efficiency of the cupola working, but care is necessary in sampling to avoid including the products of secondary reactions high up in the shaft. Much investigation is required in regard to the changes which take place in the composition of the gases between the zone of combustion and the top of the charge before definite conclusions can be drawn.

The writer has had such investigations in hand for some considerable time, and he hopes to be able to publish results at a later date.

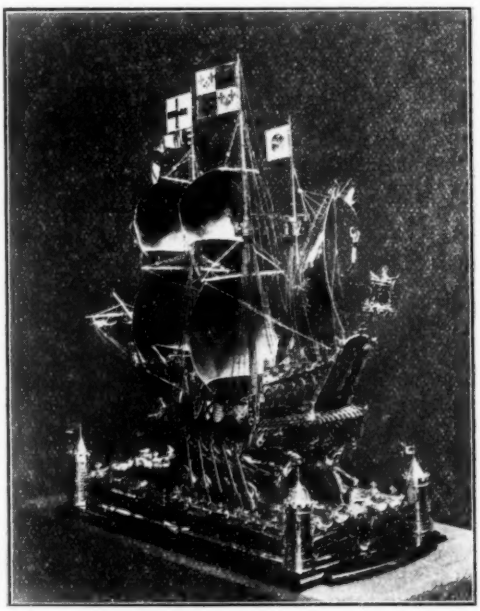
A Fine Casting.

By H. LITTLEHALES.

Not very often has a finer casting left the moulding box than that of the ship's base illustrated below. The ship itself is the product of the hammer and anvil, the base upon which it is set is the work of the foundryman, reproduced from the wax model made by the same man by whom the ship itself was fashioned.

The work, as we see it to-day, is a casting in Mond nickel, a metal under the new process perfectly malleable, and also in another form excellent in the foundry. So excellent, indeed, is it for casting purposes that the smallest imprint, even that of a thumbnail, is recorded in the surface of the casting with the utmost exactitude.

The foundryman has undoubtedly been very successful in transmuting the wax model into metal. The artist by whom the wax model was made has



nothing but praise for the manner in which his labours have been reproduced in the pattern shop and foundry.

The casting is the exact reproduction of a sea, every wave, undulation, and apparent movement of the water being reproduced exactly from the pattern.

The base or bedplate upon which the ship is set is really distinct from the ship itself, though to all intents and purposes the whole work is one.

This base is 3 ft. in length. Even on a careful examination it is not easy to detect at once that two distinct methods of fabrication have been employed, and that one part of the work has been got out by the hand direct from the anvil and hammer and the other through a pattern derived from a wax model and cast in the foundry.

In this base the little turrets at the four corners, and the exterior surrounding sides of the base with their fine cresting, form no part of the casting.

The casting consists of the sea surface with its waves and wavelets, and the lofty figure-head in the form of the head of a dragon rising from the bows of the vessel. All this is from the moulding box. With these two exceptions, the whole of the work has been made by hand—cut, hammered, filed, and rivetted together.

The whole is indeed a most striking piece of work; it was on exhibition at Wembley.

The Selling of Castings.—IV.

BY VOYAGEUR.

Having analysed the market, it must not be assumed that the next thing one should do is to begin selling castings at once. First of all, a sound selling policy must be devised. It is the selling policy that changes selling from haphazard guesswork and dissipated effort to scientific profit-making and efficient distribution. When one considers the enormous amount of money that many founders spend on advertising, circularising, catalogues, salesmen's salaries and expenses, etc., the marvel is that the expenditure itself is so carelessly checked, so inefficiently applied. It is by no means infrequent to find the foundry choked up with orders for, say, small work, and crying out for big work to keep a different set of men and machines employed, while all the time salesmen, advertisements, and so forth, keep pushing small castings down the throats of consumers. This is the kind of fault, among many others, that a consistent sales policy eliminates.

Sales Policy.

The sales policy can be considered the plan of campaign of the sales army. Its function is to provide every member of the selling staff, from the sales manager to the salesman on the road, with a certain fixed goal, easily recognisable and capable of attainment. It unifies all their activities, and permits of modification to suit differing or fluctuating conditions. It takes the waste and non-fixity of purpose out of selling. It is, in effect, the keynote of the business, the idea that all can recognise as the inspiration of their work.

In arriving at it, everything must be considered that has even a minute bearing upon distribution. Attention must be paid even to trivialities. It is often the apparent trivialities that contain the germ of success. For example, Bessemer's converter was practically useless until Mushet discovered what could be done with spiegeleisen; electrical castings in steel were a rarity until Mons. Tropenas improved upon the Bessemer converter by simply blowing along the surface of the steel instead of up through it; thousands of pounds worth of crucible steel had to be scrapped through blow-holes in the ingots, until Arnold discovered that the admixture of a minute quantity of aluminium would dissipate the occluded gases and produce a sound ingot. In exactly the same way, a minute overlooked-factor in selling may make all the difference between success and failure. For example, an American firm trebled its turnover in a year by national in place of trade advertising.

The sales policy reacts to a great extent upon the various selling activities. It indicates to the salesmen what talking points to emphasise, and what markets to attack most strongly. It indicates to the publicity manager the media for advertising that should be considered, the kind of copy he should write, the character of his circular letters, the form and design of his literature. And so to each member of the sales force the sales policy will suggest its fittest expression.

The efficiency of the policy depends to a large extent upon the efficiency of the market analysis. The results obtained by this must be carefully digested, after which the sales manager must ask himself the following questions:—

(1) Are my castings old-established in the market, or new to it? Are they of the same character as other castings of competing makes, or do they differ (*e.g.*, in composition, method of manufacture, etc.)?

(2) What class of purchaser must I attack chiefly, the merchant, the agent, the retailer, the maker of a machine of which my castings are a part, the works buyer, the actual user, or whom?

(3) What is the best means of securing sales rapidly? Advertising? If so, in what class of media (*i.e.*, trade Press, technical Press, or general Press)? Shall I need salesmen? If so, must they have had a technical foundry training? Shall I need circularising? And what other forms of publicity?

(4) For what weight, size, kind, etc., of castings am I best equipped from the production point of view? What class of castings brings me the most profit?

When all these questions have been satisfactorily answered, it will be found that the broad main outlines of a selling policy begin to appear. Thus, if the castings are composed of a different material from competing castings, and this material has definite advantages, it will possibly be found advisable to concentrate on these differences and advantages, which will mean that the salesmen, the advertising, the circularising, and so forth, will all need to hammer away at these two points, showing the reaction of the selling policy on the various phases of selling and distribution. If the best market for these castings lies among the makers of certain machines, it will obviously pay to devote special attention to these manufacturers, and focus the various selling activities upon them. This will at once influence the advertising manager in his choice of media, decide the vexed question of the previous experience and training of the salesmen, and to some extent influence the design and character of the catalogues and other publications issued. The classes of castings that yield the most profit and that can be the most rapidly produced are obviously those that will need to be most strongly advertised and pushed, which will regulate the amount of sales expenditure to be devoted to them, and similarly the amount of advertising, circularising, and so forth, of which they will form the object.

When once the formal policy has been worked out and has been agreed to by the board of directors, it should be clearly set out on paper, and every member of the sales force concerned should receive a copy for his own use. Only thus can it be made certain that the policy is comprehended and known to all. The board of directors should have an additional copy, and it will invariably be found a good plan to call a meeting of the production managers for the purpose of acquainting them with the sales policy of the firm for which they work, and of obtaining their comments. Among these men may be some who have had experience in the very markets that are going to be attacked, and from them much valuable criticism may be obtained.

Another good plan, before putting the policy into operation, is to consult the service department of some foundry or journal of good repute. Very often these journals can give, and are only too glad to do so, useful hints on marketing castings and similar products. They have a close connection with the markets, and a comprehensive grasp of the various factors that need to be taken into account, some of which might otherwise be neglected. Furthermore, they know what the trade conditions in a particular industry are at a given moment; they know the habits of buyers in that industry; and they know what the special features of the market are. Some journals offer to the small founder who cannot afford a complete advertising and selling department of his own a service that consists of suggesting marketing schemes, devising advertisements, and sometimes even preparing catalogues; for some of which they charge a fee. If a firm has small capital and little advertising and selling experience, it will find a "service" of this kind comparatively inexpensive, and probably very useful. At the same time, the founder who can afford it will always find it better in the long run to have his own selling staff, concentrating solely upon his own problems, and bringing to bear upon them experience and observation gained in his own business.

From the evolution of a competent sales policy one passes to its execution. This execution is called the "sales campaign," and needs much care and forethought. Sales campaigns are divisible into two classes, the general and the special. A following article will deal with the first of these.

Catalogues Received.

Refractory Paste.—We have received from the General Refractories Company, Limited, of Kelham Island, Sheffield, an eight-page covered leaflet describing the properties of "Plasstick," a refractory cement which they have recently placed upon the market.

Foundry Cupolas.—The Constructional Engineering Company, of Titan Works, Birmingham, are circularising the trade with a four-page brochure describing their well-known cupolette.

X-Rays in the Foundry.*

By Angel St. John, Ph.D., New York City.

Foundrymen are beginning to realise that X-rays can help them make better castings. The interest they are showing in this new development makes it worth while to present a brief description of what X-rays are, how they are used for examining castings, and what they disclose, together with a consideration of the circumstances under which their use is justified.

Theoretical Introduction.

According to accepted theory, atoms are built up of electrically-charged particles. A positively charged centre called the nucleus is surrounded by a number of negatively charged particles, called electrons. The electrons are believed to move in orbits forming a sort of miniature solar system about the nucleus. The mass and charge of the nucleus and the number of surrounding electrons are characteristic of each element, and are nearly proportional to the atomic weight—actually to the atomic number—but the electrons themselves are the same for all elements. In addition to their normal motions about the

FIG. 1.—RADIOGRAPH OF POROUS REGION BETWEEN THE RISERS OF A 400-LB. BOMB CASTING.

nucleus, the electrons may vibrate in other ways if the atom is agitated, and in so doing set up electro-magnetic or "light" waves. The force attracting an electron to a nucleus decreases with increasing distance between them, but increases with increasing charge on the nucleus. It may be shown that as this force increases the work required to agitate an electron and the frequency of the resulting vibrations both increase, very much as a short, stiff spring vibrates more rapidly than a long, flexible one.

Ordinary light is produced when agitation of the atoms displaces one of the electrons forming the outer portion of the atom; X-rays arise when the inner electrons are displaced. This is usually accomplished by the impact of a free electron moving with sufficient speed to penetrate to the interior of the atom. After such impact each displaced electron vibrates with a definite frequency depending upon the structure of the atom and the original position of the electron until the acquired energy is dissipated as radiation of the wavelength corresponding to that frequency. The X-rays given off in this manner have wavelengths peculiar to the atom and are called the characteristic X-rays of that element. The stoppage of the free electrons also sets up a series of waves, known as the general or independent X-rays, of various wavelengths exceeding a minimum determined by the speed of the impinging electrons.

* An Extract of a Paper presented to the Milwaukee meeting of the A.F.A.

Coolidge Type of X-Ray Tube for Studying Castings.

The X-rays used for examining castings are usually produced in the Coolidge type of X-ray tube. This consists of a glass bulb, highly evacuated, containing a tungsten filament and a heavy metal block, usually tungsten, called the target. The supply of free electrons is obtained by heating the filament to incandescence with an auxiliary current. The speed is imparted to the electrons by impressing the voltage of a high-tension transformer between this filament and the target. Electrons leave the filament when it is negative with respect to the target, travel to the target, and give up their energy to it. As less than one-half of 1 per cent. of the total energy thus imparted is converted into X-rays, the rest becoming heat, the target tends to become incandescent and to emit electrons on its own account. These would, in turn, travel to the filament when the target is negative with respect to it, giving rise to X-rays and additional heat in the filament. To prevent this a rotating switch is introduced into the high potential circuit and operated in such a way that the filament is always negative with respect to the target. The X-rays are then always produced at the target. The power of these tubes is limited by the rate at which the large quantity of heat can be dissipated from the target. To increase the power-capacity, some tubes are made with arrangements for cooling the targets with water.

X-rays are only slightly visible to the human eye and produce such serious physiological consequences when they fall upon any part of the body frequently or for a long time that some other method than direct vision must be used for detecting them. When X-rays fall upon a substance part of their energy is absorbed, part is scattered, and the balance passes through. When the incident X-rays are sufficiently short, much of the absorbed energy is given off again as longer waves, known as secondary X-rays, characteristic of the absorbing substance, or in certain cases as visible light. Substances having this latter property are said to be fluorescent. In some cases part of the absorbed energy may cause physical or chemical transformations, such as ionising a gas or activating a photographic emulsion.

The amount of the absorption and scattering depends upon the wavelength of the X-rays, upon the number and arrangement of the electrons in the absorbing atoms, and upon the number of atoms of each kind which are encountered, but is entirely independent of the way the atoms are arranged. Expressed in another way, it depends somewhat upon the atomic weight of the target, but principally upon the voltage across the tube and upon the composition, density, and thickness of the absorber. For a given voltage the absorption increases rapidly with the atomic weight of the absorber; for a given absorber it decreases rapidly with increasing voltage.

Protection of Operator Necessary.

In using X-rays it is necessary to protect the operators. This is done by surrounding the tube with lead of a thickness sufficient to absorb all but a negligible quantity of the rays. The most powerful outfit now in use, situated at the Watertown Arsenal, works regularly at 195,000 volts. The tube is enclosed in a lead-walled room and the operators observe the tube through a lead periscope. The outfit of the Union Carbide and Carbon Research Laboratories, used by the writer, has been operated at 115,000 volts. The tube is enclosed in a large lead box one-quarter inch thick with an air blast or an oil bath for cooling the tube. The X-rays are allowed to come through openings in the box, and after traversing the objects under examination, are absorbed in heavy lead screens.

Method Used for Examining Metals.

The method used for examining metals with X-rays is similar to that used by the surgeon in examining the human body, except that since the

materials under consideration are much less transparent to the rays a much greater penetration power is required. The X-rays record a shadow picture on the fluorescent screen or photographic film, cavities, thin spots, and foreign matter of atomic weight lower than that of the material as a whole appearing as regions of increased illumination, thick spots and foreign matter of higher atomic weight appearing as regions of decreased illumination.

In examining metals for hidden defects it is generally preferable to use the photographic method. Very weak rays which would not produce a visible effect on the fluorescent screen may be recorded on the film by a sufficiently long exposure. As the penetrating power of the rays increases, the difference in density of the photographic negative due to a given difference in thickness of the material examined is reduced. Hence, to detect small cavities or very slight differences in thickness, it is desirable to use as low a penetrating power as possible. Experience has shown that an exposure of 150-200 milliampere-minutes, that is one-half hour with an ordinary tube, is reasonable. Using a penetrating power which will produce a satisfactory negative with this exposure, cavities one-fiftieth the thickness of the specimen are disclosed. Thus, with 195,000 volts, cavities one-sixteenth inch thick have been found in steel castings three inches thick.

Explanation of Illustration.

Through the courtesy of Dr. H. H. Lester, of the X-ray Laboratory, and Colonel T. C. Dickson, the Commanding Officer at the Watertown Arsenal, a few illustrations of the use of X-rays in improving foundry procedure are presented. As originally designed, the head of a demolition bomb had extensive cavities between the risers. Modification in the shape and distribution of risers eliminated these almost completely. Study of defects in the large distance ring castings led to changes in design. Occasionally such rotten castings as the tractor grouser were detected, the cause found and eliminated.

X-rays can be of service to the foundryman in two ways. By co-operation between an X-ray laboratory, the designing room, and the foundry the causes of many typical defects can be determined and often largely eliminated, so that the proportion of defective castings can be materially reduced. Where the annual production of a given type of casting is considerable, a study of this kind may be very much worth while. In cases where much expensive work is subsequently to be done on the casting it may be worth while to examine every piece and throw out those which are defective before any further money is expended on them. If human life is to be dependent on the soundness of the casting it is possible that 100 per cent. inspection of this sort should be mandatory.

British Firms Enter Canadian Market.

Baldwins, Limited, are establishing a plant at Montreal for the purpose of supplying the Canadian market with galvanised steel sheets direct. The plant will be operated by a Canadian subsidiary concern called Baldwins (Montreal), Limited. The plant and men have already left England, and it is expected that the production of galvanised sheets will be commenced before the end of the year.

John Lysaght, Limited, of Newport and Bristol, have also announced their decision to proceed at once with the opening of a plant at Montreal. The plant will be equipped only to galvanise black sheets, but later possibly will be extended to roll sheets. "Queen's Head" and "Redcliffe" brands, which Lysaght's have long been shipping to Canada, are to be produced in the Dominion.

British Cast Iron Research Association.

The Association is undertaking an investigation to ascertain how far the properties claimed for "pearlitic" cast iron are due to the structure, and how far to other factors, and considers the use of the term "pearlitic," which is purely metallurgical, inadvisable in commercial work.

On Contraction.

By J. McL.

The writer walked into a brass foundry the other day when a gong was being moulded. It was a rush job. When questioned about the mixture, the foundry foreman said he had used ordinary scrap gun-metal and added a percentage of phosphor-tin to get a clear tone. The interesting point was that he had no cut-and-dried mixture, and yet when the casting was dug out of the sand it "rung" splendidly. It was a "rush" job, and while it was very hot it was taken into the yard to cool more quickly. A minute later there was a loud bang, and it was discovered that the casting had broken almost exactly into two halves. It was the second time the writer had seen this happen with castings of similar design. On the other occasion the casting was more saucer than dome shaped, and of heavy section, made in gun-metal. The casting was taken out of the sand when it was still fairly hot, and almost immediately it broke into three parts. The metal was of uniform thickness.

It seems rather strange that this should occur just occasionally. One can more readily understand a casting being spoilt in this way when it is made up of varying thicknesses of metal, but it appears to be almost incomprehensible when the metal is of one thickness throughout, and some castings stand the "shock" of sharp temperature change all right. With metals such as bismuth, which do not contract much, if any, the rate of changing from the molten condition does not, of course, matter so much. Shrinkage and contraction probably cause the foundryman more difficulty than other factors with which he has to contend, and it is quite surprising how satisfactorily problems are solved by practical men who have not the assistance of a laboratory. Much as rule-of-thumb practice is condemned—and often with reason—the practical non-technical foundryman is often more of a metallurgist than is realised. All patternmakers do not understand that, at the best, the contraction rule gives only approximate contraction, as each combination of metals varies in the amount by which it changes as it becomes reduced in temperature, and each has peculiarities of its own in the process.

Very small work does not, of course, cause as much trouble in contracting as large work, which has to be "eased" almost as soon as the metal is poured, the easing taking the form of digging out the cores and removing the grids. Even small work, when of aluminium or steel, frequently has to be eased. Carelessness in easing aluminium moulds will often result in cracks.

There is not usually as much trouble with comparatively thick as with thin castings. While one-eighth inch per foot may be necessary for this work, that amount in 15 in. suffices for much larger work, and even less. It is not uncommon for an experienced patternmaker to vary the contraction at different parts of a job; one part may be prevented from contracting by ribs. In a jobbing foundry where a very big variety of work is executed it is remarkable how accurate the contraction of work can be calculated. A long, cylindrical cast-iron job does not contract as much in length as in diameter. While one-tenth inch per foot is a satisfactory allowance for the diameter, one-quarter inch or even less in three feet is sufficient for the length. With larger steel work it is customary to consider each job for contraction, and base the allowance on previous experience.

Contraction troubles are often the result of lack of understanding between designer, patternmaker, and moulder. Designers have not always a reasonable knowledge of what moulding and casting means, and patternmakers sometimes consider that it is *infra dig.* to consult the moulder either about contraction or moulding methods, which determine the construction of the pattern. The correct attitude of the foreman patternmaker, especially with an intricate job, is to study the drawings until he understands every detail of design. He should then consider the moulding and how it will influence pattern construction, after which the foreman moulder—the final arbiter—ought to be consulted.

Sulphur in Coke and Cast Iron and the Methods Proposed for its Elimination or Neutralisation.*

By J. E. FLETCHER, M.I.Mech.E.

The manufacture of blast-furnace and foundry coke from coals rich in sulphur presents many difficulties, and modern "by-product" coke, though theoretically equal and in some cases superior to "bee-hive" coke in mechanical and thermal properties, appears to retain the original sulphur in a form which dissolves more readily in metal being remelted or reduced from the ore.

The coke is naturally richer or poorer in sulphur content in proportion to the sulphur content of the coal from which it is made. Hence certain Durham and South Wales coals, low in sulphur, yield cokes equally free from sulphur. It is indisputable, however, that some cokes with 0.6 or 0.7 per cent. sulphur give worse results in cupola melting practice than others containing 1.0 per cent. and over.

It has been suggested that the temperature of carbonisation and the withdrawal of the sulphate of ammonia as a by-product does affect the condition of the sulphur which remains in the coke after carbonisation. The methods of quenching the coke on its withdrawal from the coke-ovens have been thought by some experts to affect the condition of the sulphur. It is clear, however, that during its combustion in the cupola some of the sulphur is oxidised and escapes as gas, the remainder, probably in the pyrites or sulphide form, passing into the iron and slag.

Consider a concrete case where 300 lbs. of coke are used in melting 2,500 lbs. of cast iron, the coke containing 1.0 per cent. and the casting metal 0.10 per cent. sulphur. Here, assuming that 50 per cent. of the sulphur in the coke passes off in the gaseous form, the melted metal will have taken up 1.5 lbs. of sulphur and the resulting metal will contain 0.16 per cent. Experiments have shown that practically all the sulphur originally present in the charged metal is retained in the remelted iron, whilst about 50 per cent. to 70 per cent. of the sulphur in the coke is volatilised and escapes. Unless means are taken to produce a suitable slag capable of absorbing the balance of the sulphur, this appears in the metal in addition to that originally present in the iron charged.

This, then, is the condition of affairs confronting the foundryman in his normal cupola melting practice, and he is naturally anxious to find some way of abstracting the deleterious sulphur from the coke and metal during its progress from the charging stage to the moulds.

The difficulties associated with obtaining metal scrap and low-silicon pig-irons low in sulphur, and with the rapid absorption of sulphur when melting white iron (malleable) and semi-steel mixtures, are aggravated when coke of low sulphur content is not regularly available.

It is by addition to the charge or to the ladle of materials which produce a slag of sulphur-absorbing properties that a solution is being most generally sought.

Addition of Manganese Ore to the Charge.

The powerful reactions which take place between manganese and sulphur at temperatures in excess of 1,300 deg. C. are here utilised. The slag flowing down through the coke and metal mass in the fusion zone and well of the cupola is rich in manganese oxide, which attacks the iron sulphide in the metal and coke. An exchange is effected and the sulphur passes into the slag as manganese sulphide. It has been claimed that this method produces a more fluid slag and that considerable removal of sulphur is possible. It has been found in practice that when the ideally efficient amount of manganese ore is used the cupola linings suffer, especially in the fusion zone, where the lining furnishes silica necessary for the formation of the erosive manganese silicate. For this reason the method has not found much support in British foundries.

* From the October Bulletin of the British Cast Iron Research Association. The Author is the Consultant of the Association.

Addition of Limestone, Dolomite, Chalk and Fluor Spar.

When about 25 lbs. of limestone or chalk are added to each 100 lbs. of coke charged, the weight of slag produced in normal practice is approximately 5 to 7 per cent. of the weight of metal melted. If the amount added results in a lime content of 30 to 35 per cent. in the slag the maximum amount of desulphurisation is reached, the slag then containing about 0.8 per cent. sulphur. Dolomite or fluor spar additions produce a more fluid slag, but the reduction of sulphur is but little affected, and it can be readily shown that the most active element is lime, the magnesia or calcium chloride, as further additions, merely rendering the slag more mobile. It is certain that the more fluid the lime-charged slag the better is the desulphurising action. In deep-well cupolas, where the slag surface is considerably below the fusion zone, the temperature of the slag falls and its condition becomes viscous. In such a state the slag loses its desulphurising properties.

As the limestone flux method is the one most frequently used in cupola melting practice, it is well to remember that the sulphur present in the charged metal remains and does not appear to be affected by the limestone additions. It is the sulphur in the coke which can be dissipated, partly in the slag as sulphide of calcium and partly driven off in the gases, but under the best conditions possible with a lime-charged and very fluid slag a certain proportion of the coke-sulphur enters the molten iron.

Addition of Fluxes of the Lime-Manganese Type.

These methods involve the addition of manganese oxide to the slag as in the case of the manganese ore additions, and undoubtedly help to fix the sulphur in the slag. In practice, however, it has been found that these fluxes act best when a liberal amount of limestone is added with the charge, and the fluxes themselves, as sold, contain a high percentage of pulverised limestone or chalk, or are crushed slags rich in lime and oxide of manganese with or without powdered fluor spar and dolomite.

The success attending the use of this type of flux, as indeed with every other, depends on the liquidity of the slag formed and on the temperature of the slag zone. If a cupola is working with a fusion zone too high in relation to the tuyere level, the slag cannot function properly as a desulphuriser. Hence the very important fact that cupolas with deep wells are commonly associated with sulphur troubles in the metal melted, the great coke depth through which the metal has to trickle being responsible for abnormal rates of sulphur absorption by the metal.

The Use of Alkaline Fluxes containing Soda, Potash and Baryta.

The knowledge that the addition of soda, potash, baryta, and borax to a lime-silica slag or rock mineral gives a low temperature of fusion in the mixture is not of modern origin. It is, however, only recently that the fluxing actions commonly used in glass and enamel manufacture have been applied to the vitrification of cupola and blast-furnace slags.

The mechanism of the action of soda or soda-ash on the sulphides present in cupola slags or metal is not yet clearly understood. It is now known, however, that when molten cast iron is poured into a ladle, at the bottom of which soda-ash cakes have been placed, the carbonic oxide is liberated and the soda, uniting with the slag particles and iron oxide and sulphide inclusions, forms a very mobile slag or glass of low density which rises through the metal, and, acting as a scavenger, absorbs some of the sulphur present in the metal. This appears to be, so far, the only known flux which can carry off a portion of the sulphur present in cupola metal. The most fusible compounds of this type are sold under patent licences, though soda-ash cakes can be made and used in the manner described, being placed in the ladle and the metal poured in upon them.

The use of any preparation added in the foundry ladle is rarely satisfactory, as it is so difficult to get foundry operatives to put in the proper amount of soda-ash needed for the varying weights of metal to be treated. The thin, glassy slag

which rises to the surface of the metal in the ladle should be carefully skimmed off, otherwise, if it becomes cooled and sticky, there is danger that it may be poured into the moulds and flux the sand surfaces at local points, where, in positions where several planes meet, it is apt to be trapped.

The most recent development of the alkaline slag treatment is in the direction of adding the flux to a forehearth of the cupola, designed so that the metal in the cupola is maintained at a constant level—the metal passing through a partially closed trough in which the flux is placed and the excess slag flowing off continuously over a weir in the side of the forehearth.

The British Cast Iron Research Association is keeping in touch with all developments of this nature, and would appreciate communications from foundrymen whose experience in the use of fluxes might add to the better understanding of the complex reactions which occur during the slagging of ferrous sulphides, oxides and silicates.

This problem cannot be solved entirely by laboratory methods, and, though it is hoped that it will be possible shortly to determine how and why certain reactions occur between the various constituents of a cupola fluxing slag, the practical application of fluxing methods can only be deemed satisfactory when masses of molten metal can be successfully treated.

Construction of a Small Steel Furnace.

BY "CELSIAN."

The subject of constructing small furnaces is one which is very sparsely contributed to, partly due to the fact that the large majority of them are imported from the Continent. To attain a high temperature, as in the case of steel melting, the quality of the raw materials employed for the lining must be of the best possible standard.

Large numbers of small furnaces are on the market at the present time which will reach the melting point of copper, but seldom are capable of exceeding this point. Few small furnaces are capable of attaining sufficiently high temperatures to melt metals such as steel, nickel, etc. The following description shows how one of these may be constructed at moderate cost.

A hollow iron cylinder, open at one end, about 9 in. in diameter and 9 in. high, with a boss on one side at the bottom, is first secured. Best results will be obtained if this is a casting, but a good substitute can be made out of sheet metal. This cylinder is lined with a refractory material prepared as follows:—Several pounds of good fireclay are cut into small pieces and stirred up in a tub of water. The white muddy liquor formed is then poured through a common sieve into another tub, the sieve removing any hard particles which may be present. After pouring off the clear liquor the sludge at the bottom is scraped on to a cloth bag, which acts as a filter. The bag is squeezed and wrung until the surplus water has been removed, and the wet mass mixed up with a little moulding sand. This is packed into the iron cylinder to a depth of 2 in. at the bottom and sides, using the hand if no trowels or suitable tools are available. The cylinder is then placed in the vicinity of a fire, where it is allowed to warm up slowly, so that all steam is evolved without bursting the fireclay. After drying, the surface of the lining is coated with a blacklead wash and again dried.

A ½-in. hole is bored in the boss, about 2 in. from the bottom, that is, entering the cylinder on the level of the fireclay floor. To cut a hole in the fireclay lining for the pipe to enter, a sharp instrument of similar diameter should be used, the freshly-cut fireclay being black-washed and roasted as before. The size of the hole to cut rests on the pressure of gas available—this, of course, being largely responsible for the height of temperature attained. The diameter of the furnace being 5 in. (taken from the fireclay sides), and having a ½-in. hole for gas delivery, will require the pressure equivalent to that exerted on at least three jet burners.

Gas and Air Jets.

No hard and fast rule can be made as to the exact amount of air required to produce the greatest temperature, since varying proportions of air are always pumped into gas nowadays. To those who have some knowledge of the gas pressure exerted in their pipes, the hole in the fireclay could be cut to a known diameter, making allowance for the air pressure to be added. The other end of the pipe is expected to be cool when the furnace is working. This pipe end is attached by means of a special cast-iron T-piece to the gas and air supply pipe. The angle of the T-piece should not be more than 20 degs. on one side.

The pipe for conducting the air is screwed into the T-piece directly. When this has been completed the gas-pipe is sawn through immediately outside the T-piece, and attached to the main gas-pipe by means of a coupling. A brass disc about 1-5th in. thick and a fraction over ½ in. in dia. is cut, and ten pin-holes punched in it. This is fixed in the coupling between the two pipes screwed on one at each end.

To test whether the coupling and T-piece are air-tight, air should be blown into the pipes with the ends closed, under water, when no bubbles should be formed. The gas and air pipes are fitted with ordinary taps, taken from gas-pipes, the simplest method being to detach part of the latter containing the tap and then braze on, or attach by means of a coupling.

The door of the furnace is a circular slab of hardened fireclay and sand, with a hoop attached to it for lifting and laying, and is provided with three feet, which allow it to stand about ½ in. above the furnace mouth. These feet are pieces of hoop iron which are pressed into the slab when wet and soft.

Manipulation.

In manipulating the furnace the gas tap is opened and the gas lit first, then air blast is allowed to enter until the flame "roars," without sparking back. A small fireclay or plumbago crucible is charged with the metal to be melted, and placed on a small stool or piece of flat firebrick at the floor of the furnace. The action of the flame entering one side at the bottom is to travel round between the walls and crucible, making several spiral circulations upwards. When the tip of the flame escapes at the slightly opened slab it has heated all parts of the furnace in its course. As the heat on the walls develops the gas burns at a greater degree, and the temperature of the furnace quickly increases. Metals such as brass, gunmetal, etc., can be melted in as short a time as twelve minutes, and pig-iron in fifteen minutes, starting with cold crucible and using 4 lbs. of metal. Steels, nickel, etc., which cannot be melted in ordinary small furnaces, require much more time, but can ultimately be reduced to the liquid state.

The furnace will not easily get out of working order with ordinary care; but very high temperatures will wear away the lining, which should always be patched up with fresh fireclay and a little blacklead wash. Although the latter burns off it helps to bind the material and keeps it from cracking.

The lining of the walls must be quite smooth, otherwise the progress of the flame would be impeded and require longer to attain high temperatures. In some instances the lining may contract after several heats, leaving a slight space around the shell. Various mixtures are used with larger furnaces to cement the fireclay to the iron, but these need not be detailed here, as the furnace is a stationary one. As a safety measure a little dry sand or Kieselguhr may be added to fill the space and packed in on the top with a little fireclay.

Air-Draught.

Most small furnaces are supplied with air from a blower, worked by a small motor. This is usually a costly addition to make to any such furnace, and for all ordinary purposes a substitute blower can be employed which is worked by water-pressure and hence comparatively inexpensive.

XUM

Analysis of Grey Iron Foundry Alloys.—X.*

By H. H. S.

Nickel in Cast Iron.

Though there is little published data regarding the effects of nickel additions to cast iron, sufficient research and practical work has been carried out by several investigators to demonstrate that there are many possibilities which may bring nickel to the forefront in modern foundry practice. It is somewhat out of place to discuss the results of the various investigations relating to the alloying of nickel with cast iron in an article dealing with analysis, but to indicate why nickel may in many cases become a regular constituent of grey iron, and hence require to be determined along with those constituents which are usually estimated, it is worth while to state briefly the general effects of nickel, as yet known.

It has been shown that nickel tends to increase the graphitic carbon contents, in much the same manner as does silicon, but the tendency is for this carbon to exist in a finer form than usual, hence *nickel tends to refine the grain of the iron.*

The element has also a directly opposite effect, for when present to the extent of 2 to 3 per cent., *it increases the hardness* of the iron. A most important point in regard to this is that *the increased hardness is not due to an increase in combined carbon*, for the latter is not increased, but is due to partial conversion of the normal pearlite into the sorbitic phase, which, as is generally known, is harder and tougher than normal pearlite, so that the tendency is to obtain a stronger, harder, and more refined metal without increase in the chilling or decrease in machinability to any appreciable extent.

From the above rough survey one may see that in the production of thin castings or castings having thin portions, the addition of nickel may be particularly advantageous in preventing or minimising chilling. Interested readers may glean some very useful information from a study of pages 100-1 "Cast Iron in the Light of Recent Research," W. H. Hatfield; "Cast Iron Alloyed with Nickel," Paul D. Merica; "The Foundry," February 15, 1924; and "Influence of Special Elements when Added to Cast Iron," J. E. Hurst; THE FOUNDRY TRADE JOURNAL, Vol. 24, 1921, p. 514.

Nickel may be conveniently added to cast iron in quantities of about 3.0 per cent. by feeding pure nickel shot of about 20-mesh size into the stream of molten metal as it passes from the cupola to the ladle. Nickel shot* invariably has a purity of 98.5 to 99 per cent., so that there is no necessity to make analyses of this material, the makers' figure being sufficiently accurate to work to.

The Determination of Nickel in Cast Iron.

For rapidity the writer considers that the gravimetric dimethyl-gloxime is the most satisfactory for routine work, and since with care and practice an accuracy of 0.01 per cent. is not difficult to obtain, the accuracy of the method is all that can be desired.

Solutions Required.

Dilute HCl (1-1); concentrated HNO_3; dilute (1-1) NH_4OH, and also concentrated NH_4OH; 10 per cent. water solution of tartaric acid; dimethyl-gloxime, 1 per cent. solution in alcohol. It is not advisable to make a large quantity of the last solution, as decomposition sets in after a time. To make 250 c.c., weigh off 2.5 grms. of the reagent, transfer to a graduated flask and make up to the 250-c.c.s. mark with absolute alcohol, insert the stopper and shake well until the dimethyl-gloxime is dissolved. The reagent often contains a little insoluble matter, which should be separated from the solution by either decantation or filtration through a No. 1 filter paper. The solution can be kept longer without decomposing if kept in a tightly stoppered bottle and away from light.

The filtration of the precipitated nickel gloxime is best carried out in a Gooch crucible having two asbestos filtering layers. Asbestos wool, not fibre, should be used, and this is prepared by first heating a quantity of best Italian asbestos for at least one hour at about 900 deg. C., remove and cool, transfer to a casserole and add sufficient (1-1) HCl to cover the asbestos; boil well and stir frequently. After the bulk of the material has settled, strain off as much as possible of the liquid, and then add water and boil again; repeat the latter operation until the asbestos is free from acid, then transfer to a stoppered bottle, add sufficient distilled water to form a fairly thin pulp, and shake well. To prepare the filter connect up a Gooch crucible, size 2 or 3, with a filter flask and water pump, remove the loose filter disc; now pour on to the crucible base a little pulp, just sufficient to form an even filter of not more than 2 m.m.s. thickness. After drawing away the water until the filter is "set," place the filter disc in the crucible, add pulp to form another thin layer of asbestos, and again draw off the water; wash any particles of asbestos adhering to the crucible sides on to the disc, wash twice with hot H_2O, then remove the crucible and dry in an air oven for 30 to 45 minutes at 120 deg., *i.e.*, until constant in weight.

The Estimation.

Weigh off 1 grm. of drillings, transfer to a 250-c.c. T.F. breaker, cover with a watch-glass, add 30 c.c. HCl (1-1) and until decomposition is complete, then add strong HNO_3, a few drops at a time, until the violent reaction ceases, indicating complete oxidation of the iron, then add about 1 c.c. more. Evaporate to about 15 c.c., dilute with H_2O to about twice the volume, and filter off the silicon and carbon through a "40" paper; wash as directed for silicon in cast iron, allowing the filtrate and washings to collect in a 500-c.c. spouted T.F. beaker. Dilute to about 250 c.c., add 30 c.c. of the tartaric acid solution, and then strong NH_4OH until the liquid is nearly neutral; by the use of dilute NH_4OH render the solution slightly alkaline, then slightly acid with HCl (1-1). Heat the solution to 50 deg. C. and add 15 c.c. of dimethyl-gloxime for every 0.01 grms. of nickel present; stir well after the addition, then add NH_4OH (1-1) until the solution smells faintly of NH_3. Bring the liquid to just boiling, stir, remove the beaker from the hot plate, cover with a watch-glass, and allow to stand for 20 minutes in a warm place. The Gooch crucible, having been cooled and weighed, is again connected with the filtering flask. Start the filter pump and then carefully decant the clear solution from the nickel precipitate on to the asbestos filter contained in the crucible. After this solution has been drawn off, wash the precipitate into the crucible by the aid of a jet of hot water, detach any precipitate adhering to the beaker by means of a "bobby," and wash the beaker well. After allowing the washings to pass through the filter, wash the precipitate four times with hot H_2O, taking care to draw off one "wash" before adding more water; this ensures rapid and efficient washing. Remove the crucible to the air oven and dry for 45 minutes at 120 deg. C. as before. At the end of this time transfer the crucible to a desiccator and allow to cool, then weigh.

The period of time mentioned for heating the crucible and precipitate is usually quite sufficient to ensure that the first weighing is constant, hence saving time which would otherwise be taken up with re-heating, cooling and weighing, provided that the asbestos filter layers are not too thick. The essential is that the weight taken for calculation should be constant for a particular estimation. The weight of the nickel precipitate × 20.31 = the percentage of nickel.

When nickel contents is anticipated to exceed 1.0 per cent., a 1-gramme sample is sufficient to employ for the estimation; when it exceeds 0.5 per cent., but not 1.0 per cent., a 2-gramme sample is recommended, and below 0.50 per cent., a 3- or 5-gramme sample should be taken.

* Nickel is often contaminated with oxide, which unless care is taken is liable to give a higher nickel percentage than the truth. —Editor.

London Foundrymen Visit large Automobile Factory.

On November 15 about 35 members of the London Branch inspected the Cowley, Oxford, works of Morris Motors, Limited. At a luncheon offered by the firm, Mr. A. Smith, the foundry manager, presided, and in reply to the toast of "The Prosperity of the Firm" (proposed by Mr. V. C. Faulkner, the Branch-President) said that though a year or two ago their foundry was definitely modern, it was now obsolete, because of the phenomenal growth of the business. However, the foundry still possessed many interesting features, such as the Lucas continuous core-drying stoves; the sand slinger, with its underground sand-conveying system and its circular track carrying six Britannia stripping machines; the moulding-box-part system; the internal transport system; and a new method for turning over boxes.

A GROUP OF MEMBERS OF THE LONDON BRANCH OF THE I.B.F. AT THE WORKS OF MORRIS MOTORS, LIMITED.

Book Reviews.

Lime and Magnesia, by N. V. S. Knibbs. Published by Messrs. Ernest Benn, Limited, 8, Bouverie Street, London, E.C.4. Price 30s. net.

The author and the publishers both state that hitherto no publication has appeared covering the important subject of lime and magnesia and their application in industry. This statement is quite correct, and the present volume now rectifies the omission in a very thorough manner, not only giving a detailed consideration to almost every aspect of the subject, but also numerous references to the very scattered literature.

The first part deals in nine chapters with the chemistry of calcium and magnesium oxides and carbonates, including dolomite, together with the burning process, and the methods for analysis and testing.

The second and most important part of the book is concerned with the complete technical details of lime and magnesia burning, including the quarrying of the natural rock, the design and operation of the kilns, and various processes of hydration. This is the best part of the book, although a very surprising omission is any reference to the "Schulthess" lime-slaking machine, one of the best-known makes.

The third and final portion relates at considerable length to the different application of lime, particularly agriculture, building work, the chemical industries (this latter chapter being especially interesting), and various miscellaneous applications, the whole forming an impressive indication if the industrial importance of lime.

Finally, there is a chapter on the applications of magnesia, useful appendices, and a good index, whilst the printing and production, including 48 illustrations, are of a high-grade character.—D. B.

Developments in Power Station Design, by Edwin Austin. Published by Constable & Company, Limited, 10-12, Orange Street, London, W.C.2. Price 31s. 6d. net.

Mr. Austin is on the staff of the "Engineer," and the present volume is essentially a reprint of a rearranged series of articles on "Developments in Power Station Design," that appeared in the "Engineer" during 1921 and 1922. The book deals with a great variety of subjects, including pulverised fuel, oil fuel, low-temperature carbonisation, the utilisation of air heating, pneumatic and water-sluice ash conveying, turbo generators, high-pressure steam and various electrical plant, such as switchgear, transformers and rectifiers. In writing any book dealing in a general way with the multitudinous aspects of steam power station, the main trouble is that the rate of evolution to-day is so remarkable that even the author of an article is apt to be considerably behind with his data, so that the proposition becomes almost a hopeless one as far as books are concerned. The present publication naturally suffers very severely from this inherent difficulty. The chapter on low-temperature carbonisation, for example, is merely concerned with the "Tozer" process, out of about 50 different methods, but, however, one is glad to see this reprinted, as it is the best description of the Tozer process that has yet appeared.

The chapter on pulverised fuel is perhaps the most unfortunate in this respect, and since 1921-1922, almost a revolution has taken place in pulverised-fuel firing, whilst the short description given of the Lakeside station at Milwaukee gives a very inadequate idea of the true state of affairs. The chapter on high-pressure plant contains an interesting description of the Power Duffryn installation, but here again we are afraid the world is moving far too fast to-day for harassed authors. Finally, the printing and illustrations are excellent.—D. B.

Institute of British Foundrymen.

BIRMINGHAM BRANCH.

Following a visit to the works of Messrs. Harper Sons & Bean, Limited, on Saturday, November 15, the members assembled at the Institute, Wolverhampton Road, Dudley, to hear an address on "Aluminium Castings" by Mr. C. Dicken. The BRANCH-PRESIDENT (Mr. Thomas Vickers) was in the chair, and there was a large attendance.

The PRESIDENT spoke of the educational value of the meetings. They met on common ground and spoke their foundry ideas in foundry language. (Laughter.) There was no doubt that a man who joined the Institute obtained substantial benefits. Objection to men joining was sometimes raised by employers on the ground that they might give away secrets of the firm. That fear, however, was fast being removed. He appealed for an increase in the membership from the Dudley area, remarking that the Institute ought to have sufficient members in that district to enable them to hold two or three meetings there during the session.

Introducing Mr. Dicken, the President said he was a past-President of the Coventry Branch and had made the matter of aluminium castings a personal study. Aluminium, he added, was one of the coming metals for all ranges of engineering work, and especially aeronautical work.

MR. DICKEN then read his Paper, which was illustrated by a number of interesting lantern slides.

ALUMINIUM CASTINGS.

Aluminium is considered to be one of the most important metals, and there are many brass founders anxious to branch out in the aluminium trade because their own business has so much decreased owing to stampings replacing brass castings, and because of the increasing popularity of aluminium, chiefly for the aero and automobile trade, but also for domestic and electrical purposes. This Paper may then assist anyone who may be seeking the method to produce aluminium castings. Progress with this particular metal has been remarkable during the last 18 or 20 years.

Aluminium in its pure state is not much used, owing to the elongation being too high and the tensile strength too low, but when alloyed with other metals it is increased in strength. Each of these alloys have their own particular properties and uses.

During the war the Air Board laid down several specifications which have since been brought into general use for commercial purposes, such as the L5 alloy, which contains 2 to 3 per cent. Cu, 12 to 14 per cent. Zn, and the remainder aluminium.

This alloy is much used in the automobile trade for producing both light and heavy castings, such as crank cases, gearboxes, rear axles, etc. It is a fairly strong metal, having a tensile strength of 10 tons sand cast and 14 tons chill cast, with an elongation of 6 per cent. when sand cast and 4 per cent. when chill cast.

The L11 alloy, containing 7 to 8 per cent. Cu, 1 to 2 per cent. Sn, and the remainder aluminium, is a metal that will stand a fairly high temperature and is, therefore, most suitable for castings such as cylinders. Castings which have to withstand a considerable stress combined with high temperature are best cast with this alloy.

The L8 alloy, containing 88 per cent. aluminium and 12 per cent. Cu, is universally known as "piston alloy." It is suitable for castings which are to be cast in a permanent mould where elongation is not required. As the permanent mould method of making castings saves machining, it pays in the case of various castings, although of course the cost of the mould must be considered, and so this method of production is only economical if there are a large number of the same castings required. The tensile strength of this alloy is 10 tons per sq. in., and about 1 per cent. elongation when chill cast.

An alloy containing 5 to 13 per cent. Si and the remainder aluminium is used by a few firms holding patents for different methods of production. This alloy is not widely known at present, but is undoubtedly an alloy which will, when more generally understood, assist greatly in overcoming many difficulties which arise in casting, feeding and porosity.

Selection of Metal.

There are two important points to remember concerning the so-called aluminium scrap which is upon the market. Firstly, aluminium castings made 12 or 14 years ago were very far removed from the castings of to-day so far as quality of metal is concerned, and then, too, aluminium does not improve with keeping. Besides these facts, refiners are buying swarf turnings and sawings of all types of alloyed aluminium and placing them on the market in ingot form.

In some machine shops where castings made from L5 and L8 alloys, phosphor bronze, gunmetal, white metal, iron and steel are machined, the operator (who is usually working piecework) cannot afford the time to be extremely particular about the turnings, and so sometimes L8 turnings are mixed with white metal because they are both white, and perhaps through carelessness a little phosphor bronze, gunmetal and sometimes iron and steel too. A very small portion of any of these metals will spoil the physical properties of aluminium. On one occasion the author bought some "re-melt" and had a test bar made which passed the laboratory for both physical and chemical results, and yet he was surprised at the weight of an ingot. It weighed 6½ lbs., whereas an ingot of the same size cast from L5 alloy made from virgin metal weighed only 6 lbs. This explains why customers now prefer to buy aluminium castings per unit instead of per lb.

Melting Details.

Aluminium may be melted in gas-fired tilted furnaces, pot furnaces, oil- or coke-fired furnaces, and sometimes in reverberatory furnaces. For the L5 alloy the preferable way to introduce the Cu into the aluminium (owing to the difference in melting temperature) is to make a 50:50 alloy. This is made by placing 50 lbs. of virgin Cu into a crucible in the furnace (well covered with charcoal to prevent oxidation), and when heated to a temperature of about 1,150 deg. C., 50 lbs. of aluminium should be cut into small pieces and added a little at a time, so that the temperature is not too suddenly reduced. When this is melted thoroughly the molten metal should be well stirred with a graphite stick, or an iron bar covered with graphite, and then poured into ingot moulds. To prepare metal for casting 82 lbs. of aluminium should be heated to about 750 deg. C., 5 lbs. of the 50:50 alloy should be added, and when melted 13 lbs. of zinc should be held in a pair of tongs and moved about in the molten metal until melted. This should then be drawn from the furnace and the moulds poured according to the given temperature. In the case of L8 alloy the mixture would, of course, be 76 lbs. of aluminium and 24 lbs. of 50:50 alloy.

Temperature.

It is not possible to state a definite temperature for casting aluminium, because as the design and thickness differs with each type of casting so must the temperature also differ, but each important casting should be cast by the aid of a pyrometer. Metal too hot is the cause of many wasters, for although the analysis of burnt aluminium differs very slightly from metal melted correctly, yet it reduces the tensile strength, deprives the casting of its elongation, and removes that elasticity which should enable it to yield when contracting. Personally the author considers 700 deg. C. to be the best temperature for most castings.

Patterns.

Before commencing to mould, it is very necessary to examine the pattern thoroughly and to notice the position of the thicker sections. Great importance must be attached to the rate of cooling. If it is found to be impossible to feed the thicker sections whilst the thinner sections are contracting, then it is necessary to use chills.

Sometimes pieces of flat or half-round iron can be used (as in crankcase corners). In the more intricate sections it may be found to be necessary to mould plaster patterns to make special fitting chills in gunmetal or iron. It is not possible to enunciate a hard-and-fast rule as to where these chills should be used. It usually depends upon the distance between the runner and the thicker sections. The aim in view should be to feed the casting so that the same rate of cooling takes place in each section. It is only by paying careful attention to this that a sound casting, free from porosity, can be produced. Patterns should preferably be placed upon moulding machines. Cores should be released from the casting as soon as possible.

Running.

This is another important point but one which must vary with the particular casting. In the majority of cases it is wise to have the runner on a thin section. This is not always the quicker method, but the result is more likely to be successful. When the runner is on the thicker section, flat-bottom bushes should be used to avoid oxidation.

Moulding.

Sand suitable for aluminium castings is just an ordinary fairly tough mixture of red and black sand. Great care must be taken to place the chills close to the pattern, and these must not be moved in the ramming of a mould. In cases where loose patterns are used the moulder should make a practice of rapping the pattern a definite number of times each way so that if a quantity of castings are required from the same pattern each casting will have received the same amount of rapping, and the weight of each will consequently differ very little. The facing of the mould after the pattern has been drawn is a matter which has caused considerable discussion. Some foundrymen maintain that the best method of obtaining good results for castings, such as crankcases, gearboxes, etc., is to paint the mould with a mixture of graphite and water and dry with a blowlamp, or gas with an added pressure. Others prefer to mix the sand with a percentage of moisture and brush the mould with dry French chalk and then dry, but experience and various experiments have shown that the best results are obtained by using dry sand with a little water (91 of sand and 9 per cent. of water), mixed with the shovel and put through the sand mixer, rammed in the usual way, and then the mould faced with an equal percentage of graphite and French chalk, using a brush for this process, and cast in a green state. Much care should be exercised concerning the chills. To ensure these being absolutely dry they should be heated and allowed to cool.

Blow-Holes.

It has been found that most of the machine-shop operators consider this to be almost the only cause of scrap, but to prevent scrap from this particular source foundrymen must consider the root of the evil. One class of blow-holes is caused when the gases cannot escape through their proper channels, when the sand contains an excessive amount of moisture, or if the mould has been rammed too hard, thus causing the grains in the sand to be so close together that it deprives the sand of its necessary porosity, and when the metal is poured the gases are unable to escape through the pores of the sand, and of course blow-holes must result. Damp chills may easily cause blow-holes. If insufficient care has been taken concerning the drying of these, and the metal comes in contact with the moisture, causing steam to arise, the result is sure to be a scrap casting, the chief objection to moulds being faced with wet graphite and skin dried is that there is a great danger of scrap from this method. The mould may appear perfectly dry, but there is a possibility of steam arising from the back and sides of the chills which may travel to the face and so cause blow-holes.

Tubes are often cast in crankcases, and it is sometimes necessary to make many experiments before these can be successfully cast without blow-holes. Castings which reveal holes on the top faces after machining are usually caused through the metal being cast at a low temperature. So-called blow-holes which are exposed after the first turning in the lathe are sometimes due to the metal having become oxidised as it enters the mould.

DISCUSSION.

MR. E. H. TYSON, in opening the discussion, said he had always made crank cases the opposite way from the author, that is, face downwards. In such castings they had often to try different methods of running. In a great many cases he ran them with horngates. He remembered two very similar crank cases that were being made, both of which were run with horngates. One was a success, but the other being slightly differently constructed, there was trouble with blow-holes on the valve guide bosses. He favoured green-sand moulds and cores, but they had to control the moulders closely because they would work the sand too wet. That was often the cause of blow-holes. Where there was a large flat face on a casting blowholes were often found underneath the surface due to the metal having been at too low a temperature. The sand-cast piston always revealed speckled metal when machined. They could get over the trouble by chilling, but the problem was to make a sand casting without chilling and endeavour to get rid of the speckled metal which showed up on the machine.

MR. D. WILKINSON said the troubles he had experienced in aluminium were a distinct class and required rather different methods to overcome from those which might be applied in the case of ferrous metals. With aluminium he had always found it better to try to cast at as low a temperature as possible. When rather stringent specifications had to be met, it was not generally considered wise to run the temperature much above the melting point. To overcome trouble with trapped air he favoured the use of a horn gate, forcing the metal in with great rapidity and putting a considerable riser on the higher part. One should not exceed the melting point of such alloy by more than 40 degrees. He admitted that it was not always possible to adopt that method. The only alternative was to increase the temperature of the metal and run the risk of the open grain of the casting reducing the strength beyond the desired limits. One of the great difficulties of the conscientious foundryman was to overcome in the best way he could the awkward designs the designer put out. With careful chilling, melting and gating, some of the weird designs that were submitted could be cast satisfactorily. It was much to be deplored that awkward designs were sent out, because difficult castings could often be simplified to the advantage both of the founder and the engineer. By careful attention to the runners and feeders, and above all to the melting, so that there were no oxidation troubles and no trouble from the nitrogen of the atmosphere combining with the aluminium, it was possible to succeed in producing satisfactory castings which at first glance seemed impossible. Speaking generally, he considered aluminium was a fairly easy metal to handle if it was remembered that the greatest care must be exercised in melting and in avoiding trapped air in the castings. In ordinary iron they had a metal of a specific gravity of 7.2, and in the case of an ordinary aluminium alloy they were dealing with a metal of about one-third that specific gravity. There was also a difference in the viscosity of the two metals. Two things in the case of aluminium made trapped air much more troublesome to deal with than in the case of cast iron. One was the added viscosity and the other was the low specific gravity, and the problem of producing a good casting had to be approached from a different standpoint. It was a great deal less expensive to cut off, say, 10 per cent. of metal and secure a sound casting than it was to have an additional 4 or 5 per cent. of waste castings, while there was the satisfaction of feeling that one had secured a good casting which, when machined, gave the minimum amount of scrap.

MR. ALDRIDGE inquired what was the best flux and also if the lecturer could supply him with

the analysis of a suitable mixture for aluminium patterns for odd side work.

Proposing a hearty vote of thanks to Mr. Dicken, MR. J. B. JOHNSON said he had given a thoroughly practical Paper.

MR. F. G. STARR seconded the motion, which was enthusiastically endorsed by the meeting.

The Author's Reply.

In reply, MR. DICKEN reverted to the question of trapped air, remarking that once when he was on holiday the supervision of the foundry was entrusted to a man who thought he knew the best temperature at which to cast crank cases, *i.e.*, 660 deg. The result was that there was not a casting that did not show blow-holes on the top face. A temperature of 700 deg. would be considered rather high by the majority of aluminium founders, but owing to casting at 700 to 710 deg. they had obviated the trapped air trouble. Aluminium founders would bear him out that they cast a test bar as a rule half-chilled, and that was accepted. But if they took a bed-plate casting and cut six pieces of metal from six different places, had them turned up and put them on a tensile machine, they would not get two parts which gave the same tensile strength. He disagreed with Mr. Wilkinson that aluminium was a fairly easy metal to cast.

Mr. Dicken, continuing, said it was not necessary to vent green-sand cores for aluminium. It was not even essential to vent all dry-sand cores. He admitted, however, that there was a certain amount of risk in not venting dry-sand cores. A great deal depended on the ramming. As to fluxes, he said he used all virgin metals for everything, and he never fluxed his first melts because the flux left dust. There was a danger of the dust getting into the castings and causing holes. He took the skimmings from the first melt and put them through the furnace and fluxed with chloride of zinc. With regard to the analysis of a metal suitable for patterns, he recommended 88: 12, because it had the least contraction and would be a very suitable metal for small patterns. He could supply the analysis of a good pattern metal, but a very expensive one. Its contraction was $\frac{1}{2}$ millimetre to the foot. That was 50 per cent. tin and 50 per cent. zinc.

LANCASHIRE BRANCH.

Visit to Internal-Combustion Engine Works.

The Lancashire Branch has been singularly fortunate during the past few months in the works that the members have visited, no less than five well-known firms having thrown open their works to the members for inspection. The last of the series of visits took place on Saturday, November 8, when nearly 100 members and friends visited the Stockport works of Messrs. Ruston & Hornsby, Limited.

The visitors were received by Mr. R. Onions, the manager, and Mr. A. L. Key, the foundry manager, who is a Past-President of the Lancashire Branch, and these gentlemen, together with other members of the staff, conducted the party round the works in small groups. The testing departments were first visited, and these were followed by inspection of the erection and machining departments, the tool-room, power-house, pattern-shop and the foundry.

The work done at this works consists mainly of the manufacture of internal-combustion engines. This is work that requires a high grade of casting, and the visitors were impressed by the very high quality of the work they saw passing through the shops. The outstanding features in the foundry are the very extensive use that is made of jolt ram machines and of oil-sand cores. Large and complicated castings are handled expeditiously on the jolt ram machines, and a very complete layout is provided for coping with the work. Oil-sand cores of a large and very complicated character are made.

At the conclusion of the visit the directors entertained the visitors to tea. The thanks of the party were voiced by Mr. R. A. Miles, the President, and Messrs. E. Oakden, J. Simpkiss and G. E. Windeler. In reply, Mr. R. Onions spoke of the last visit of the Lancashire Branch to the works 14 years ago. He dealt with the changes which had taken place in engineering practice in the meantime, and with the rapid growth of the Institute, and particularly of the Lancashire Branch, during the same period.

LANCASHIRE BRANCH (Junior Section).

The inaugural meeting of the Junior Section of the Lancashire Branch was held at the Manchester College of Technology on Saturday, November 15. The Branch President, Mr. R. A. Miles, occupied the chair, and was supported by the leading members of the branch. There were also present a large number of the young people for whom the section is intended to make provision, the total attendance being 240. In the course of the evening the President announced that he had received a telegram from Mr. Horace J. Young, F.I.C.: "Have great hopes that this will become a national movement. Heartiest wishes to you all." The secretary of the Junior Section of the Newcastle Branch had also sent the heartiest wishes of his members for a very successful session. At the close of the meeting 140 applications for membership were received, and this number has since been increased to 200, and many more are still expected.

Mr. W. H. Sherburn, of Warrington, gave an address upon "Foundry Craft."

In proposing a vote of thanks to Mr. Sherburn, Mr. Oliver Stubbs, Past-President of the Institute, said the object of the section was to bring together the young people in the industry so that they might improve their knowledge and prepare for the competition which was bound to take place; and if they would give their minds to it they would undoubtedly succeed. In the course of his visit to America some two years ago he was in most of the principal foundries, and there could be no question about it that over there people gave their minds to their work. He observed some things in which their example should be followed; but he saw no heavy castings, particularly those which required what he should term craftsmanship, apart from machining, which excelled those produced in England. It was up to the coming generation to maintain the traditions of the past. Let them take real interest in their work, and see if they could not continue to uphold the claim that this country produced the best castings in the world.

Mr. S. G. Smith seconded the vote of thanks, which was passed with acclamation.

The Secretary of the Lancashire Branch, Mr. Tom Makemson, who is largely responsible for the organisation of the new section, circularised and sent literature to over 200 firms in South-East Lancashire. All the firms which were approached responded readily to the appeal and endeavoured to arouse the interest of all their employees who are eligible for membership. The assistance of some twenty technical colleges and other organisations was also solicited. The Council of the Lancashire Branch is very grateful to those firms and other bodies for the amount of interest that they displayed and for the work that they carried out.

The rules of the new section provide for a considerable amount of self-government on the part of the members. There will be a President and Vice-President elected by the members of the Junior Section from among the members of the Senior Section. A Secretary and a Council of six will be elected by the juniors from among their own number, and in addition the President and Secretary of the Lancashire Branch (Senior Section) have ex-officio seats on the Council.

It is expected that the first election of officers will take place at the December meeting of the Section.

Applications for membership from young engineers and foundrymen will be welcomed by the Secretary of the Lancashire Branch, Mr. T. Makemson, 21, Beresford Road, Stretford, Manchester, and he will also be pleased to furnish information to any prospective members or to any firm who would like to have further particulars.

Discussion on Mr. Stevenson's Paper on "Modern Patternmaking."*

Green-Sand and Oil-Sand Cores.

MR. A. SUTCLIFFE said, in making cores for jobs of the kind described by Mr. Stephenson, he had found gum sand quite as efficient as oil sand for block cores, which are nearly all print, and additionally, it was cheaper. The cost worked out at about 5½d. per cwt. Using oil sand, the cost was about 2s. to 2s. 2½d. per cwt. He had made many rope pulleys weighing up to 20 tons, and he was not in agreement with Mr. Stephenson as to the method which should be adopted. To take one example from the author's practice, a pulley wheel was grooved at the back, facing each groove at the front. It could be made off a block in green sand on the outside and dried, and the inside put in with cores. He (the speaker) had made these in loam blocks in place of bricks, and also in block sand cores for round the outside, the latter being preferable.

Another job he made for Mr. Stephenson was an air pump in loam. A month later, having to make one for himself, which was similar but heavier, he cut the pattern in two and made it in dry sand, and he made it in a third of the time the first one took.

MR. J. MASTERS said the use of oil sand in these castings was a matter of experience. At the present time he was making in oil sand a job in which there was a 9-in. section of metal.

MR. STEPHENSON said in the cores of the castings he had spoken of the material might be a little in excess, but the cost of labour was considerably less, and the net result was a cheaper job. This portion of the job could not be made in ordinary core sand in an hour and a-half. They used oil sand for all sorts and sizes of castings. Mr. Kay, the foreman, would perhaps give some particulars.

Large Fly-Wheel in Oil-Sand Cores.

MR. KAY said they had made in oil sand a fly-wheel weighing 37 tons, in which the section of the metal, the outside rim, was 20 in. by 22 in. It was a solid rim, with cores to cover the top. A few weeks before they cast a shear body, the weight of which was 14½ tons.

MR. A. L. KEY said in loam moulding the choice between strickling and making a block was a matter of experience, and dependent upon the locality, the management, and other circumstances. He doubted whether one method alone could be definitely declared to be the cheapest, to cover every job that was moulded in loam.

MR. STEPHENSON said, in special cases, blocks were made by his firm. In the Paper he had pointed out that it was not possible to traverse the whole ground in pattern-making, and when he mentioned strickle work he was referring to engine cylinders. It did not matter whether they were of the Corliss or the drop-valve type.

MR. MASTERS said he had a casting to make which weighed 14½ tons. On the first occasion a block was used, and it cost 19 weeks' labour. On the second occasion it was made with a block, and the time was 6½ weeks.

What were the results in making large pulleys, say 20 tons weight, in oil-sand cores? Should the cores be put in segments, or as oil-sand cores complete, and finish the segments, or was it preferable to put the loam core with the grooves partly on and then slip them up afterwards in order to get a more accurate casting?

Pulleys in Oil-Sand Cores.

MR. STEPHENSON replied that the practice at Messrs. Musgrave was to make a segmental box containing the correct number of grooves required in the pulley. They were put round the mould, secured, and cast in that way. There was no striking up. At another establishment, where he served his time, the practice was to make the cores in a similar form, put them on, and strike them on the mould. By that the amount of machining required was reduced to a minimum. But to his mind, assuming the grooves had been set very accurately—and they must be set accurately—the cores, when they came from the box, were suitable for making the mould and sufficiently good for the machine shop. The machine shop generally took a parting cut across the top to give it its diameter. Then they put down what was called a cutting tool. In the use of the cutting tool it was immaterial whether the joint was slightly stepped or not, because a straight line was cut right away down to it, and where the joints overlapped it took a wider cut than elsewhere. As far as their experience went, it was not necessary to strickle up the cores after they had been laid down.

MR. MASTERS said he held that no oil-sand core would stand the pressure of a rope pulley and be accurate; there must be an extra wide margin for machining. By slipping the cores with a loam spindle, after they had been put into position, the machining was reduced to a minimum; it was not necessary to have more than ¼ in. machining on the casting.

MR. STEPHENSON said they never allowed ¼ in. machining on the angle of the groove. For large pulleys $\frac{1}{16}$ in. was all they allowed. Of course, if the moulder was not so accurate as he ought to be, and made the castings a little in excess in diameter, the turning was increased, because the angle was running away from the diameter, and, in consequence, it slightly thickened the metal that had to be taken away. But when using the tool, it did not matter whether the groove overlapped or not. The tool, cutting down the face in the first instance, took a straight cut; then the sides were brought into play. Of course, he was not speaking of an overlap of something like $\frac{3}{16}$ in., he was speaking of an overlap of something like $\frac{1}{16}$ in. or $\frac{3}{32}$ in. If the marginal allowance was $\frac{3}{16}$ in., they had still $\frac{3}{32}$ in. to play with.

Probably Mr. Sutcliffe found some difficulty with the method which had been in operation at Messrs. Musgraves because it was the first one he had made under those conditions, and when one took up a new thing, a difficulty was experienced in operating it. But he could not agree that to build the cores up separately and strike them up was more expeditious than putting them down in segmental form in a core box. They had tried it at their works, and it was very expensive. It happened that a foreman came along who would not have the core boxes; he preferred to build up. So he built the pulleys up groove by groove, used the grids, and so on. It took five days to build up and finish a mould 4-ft. dia. with 12 grooves. It was the first that had been done in that way, and naturally everybody was a little bit lost so far as it was concerned. But they very quickly reverted back to the old method. He quite agreed that the appearance of the casting produced by the old method was not so nice, but that weighed very little with him if it was a machined face. They had found no difficulty as far as the machining was concerned.

MR. PERRYMAN asked for some further information regarding the ramming of the rope pulleys. His own practice was to ram the top part up on the plate. The centre was generally covered by a loose plate. He understood Mr. Stephenson to say they rammed the arm, and then they rammed other cores up in between. He did not do that himself, but rammed the cores up to the arms, and then rammed the rim part with anything they could get between the arms and the spindle. They did not bother with any core in between.

A MEMBER observed that the system he adopted was to ram it up, to take off the top part, and to ram up the centre. There was 6 in. parting on each side of the flange.

THE CHAIRMAN reminded the members that this was a Paper on patternmaking, not on moulding. It went to prove that co-operation between the patternmaking department and the foundry was essential.

* See last week's Journal.

Skeleton Patterns for Turbines.

MR. MASTERS said he would like to express the opinion that for turbine work the complete skeleton pattern was the best method to get a true casting. Quite recently he had occasion to make a turbine casting, and it came out satisfactorily from the foundry point of view, both as to casting and appearance. When the pattern was made originally there were so many radii in it that it could not be made from a drawing; the patternmaker had to be in the foundry constantly to make his patterns after the radii had been formed. Eventually it came out a very good pattern. They got the casting a uniform thickness quite satisfactorily. Just by taking a complete skeleton pattern it was made quicker than any casting of a similar character previously made.

A friend who had been in Belgium informed him that the moulders there made little use of patterns, even with castings which weighed 15 to 30 tons. He had himself seen Belgian castings, but nevertheless he believed that the British moulder could hold his own with the Continental moulder if he had the same facilities.

MR. MEADOWCROFT said he believel there were more jobbing foundries in Lancashire and the West Riding of Yorkshire than in any other part of the country, and the jobbing foundry suffered a great deal from bad patterns. Every foundry had its own methods, which varied in some respect, it might be only slightly, from the practice of others. Where one system had been in vogue it was not wise to introduce another without satisfying oneself what the man could do. Even if it was better, then men, not being accustomed to it, did not appreciate it.

The remarks on the necessity for a good understanding between the patternmaker and the moulder were very useful. An instance occurred to his mind, where they were making a big frame casting weighing about 6 tons, with outstanding brackets. It had all sorts of loose pieces. It used to take a couple of days to set it up. The patternmaker talked it over with the foundry people, about £15 was spent on a block, and it was set up in 4 hours. Practically half the cost was saved on the first casting.

MR. NOBLE said some years ago his firm, being overwhelmed with orders, obtained castings from Belgium, and patterns were sent out. When they were returned some of them were in a very bad condition, and, additionally, a large portion of the castings had to be made over again. The Belgian moulders were not ahead of the moulders in this country. Often a foundry foreman had to send a pattern back, and alterations cost a good deal of money. If the manager of the firm would encourage co-operation between the foundry and the pattern shop there would be a considerable saving.

Vote of Thanks.

MR. J. PRESCOTT, in proposing a vote of thanks to Mr. Stephenson, said the Paper brought forcibly to their notice recent developments in the industry in respect to moulding and patternmaking. Reference had been made to the new block system, which had been gradually adopted. When he first started in the foundry department the block system was in use, although it was not quite what was seen to-day. It had been mentioned that castings had been made wholly from cores. It was bringing moulding down to very simple terms; they were becoming assemblers of cores, and that system had been in operation for a number of years for rope pulleys and various other castings.

MR. H. STEAD, in seconding, agreed that it was essential the pattern shop and the foundry should be in close touch with one another. It was false pride for either a moulder or a patternmaker to imagine he knew his job so well that the other could not teach him something about it.

MR. H. SHERBURN, supporting, said reference had been made to a point which was of vital importance and also sometimes difficult of solution. That was co-operation between the pattern department and the foundry. The pattern department had its special difficulties to overcome. It had the productive aspect of the foundry to consider, and there were all kinds of technical problems associated with design to be considered. Heavy expenditure was often incurred in patternwork which might be thrown over at the last moment by the man in charge of the foundry. That left the patternmaking department in a very difficult position. He much appreciated Mr. Stephenson's presence with them and the Paper submitted. By getting in touch with one another in these discussions they would make better progress. They ought also to know something of what was happening on the Continent. A few weeks ago he had the pleasure of going through a foundry at Werkspoor, in Holland, which promised to be on conclusion most admirably organised. The melting equipment was remarkable, and the methods of handling material and organising the work excellent. The foundry had been designed under the personal superintendence of Mr. Van Aarst, who was undoubtedly one of the foremost foundrymen of the present day, and any member who visited it could be sure of a hearty welcome. He would also be sure of getting valuable instruction, and he would be able to form an idea of the best Continental and American designs for producing patterns and modern equipment in cranes, hoists and cupolas. In this country one was apt to become insular in his ideas, and an opportunity of slipping over to the Continent tends to enlarge one's knowledge, and should not be missed.

The vote of thanks was passed unanimously. In reply, MR. STEPHENSON said he had always valued co-operation with the foundry, and had carried it out in practice. He would go further, and say that the co-operation of the drawing office was also essential. When the design was sent into the pattern shop is was not always perfect for obtaining economical production. Therefore where he was employed the drawing office frequently called into consultation the patternmaker or the foundry foreman, and sometimes both of them.

New Plans for British Industries Fair.

An important development in the British Industries Fair for 1925 is announced by the Department of Overseas Trade and the Birmingham Chamber of Commerce.

Owing to the proposed reopening of the British Empire Exhibition, the Department of Overseas Trade has decided to suspend the London Section of the British Industries Fair until 1926, as a temporary measure for 1925 only. Arrangements have consequently been made by the Birmingham Chamber of Commerce to organise sections in their Fair for industries which have hitherto exhibited, and would ordinarily exhibit, in London, provided adequate support is secured.

This departure, it is considered, will have a number of advantages for manufacturers and trade buyers alike, especially for visitors from overseas whose time at that season is limited. Many branches of industry are so closely allied that, however carefully the sectional groups were arranged, buyers often found it necessary to duplicate their visits. Also, as it now seems certain that the British Empire Exhibition is to be continued next year, the holding of the combined Fair in the Midland industrial capital will emphasise the distinction between the two events, one being a public display of Empire activities and the other, open only to trade representatives, solely a commercial buying centre.

The British Industries Fair at Birmingham will be held from February 16 to 27, those dates having been chosen as most suitable by means of a referendum to the exhibitors themselves. The Birmingham authorities are fortunate in having ample accommodation at Castle Bromwich for the combined Fair, and arrangements have been made to place a large additional building at the disposal of exhibitors.

MR. WM. MCLEAN died at his residence, 8, Riverdale Road, Sheffield, on November 13. The deceased gentleman, who was 49 years of age, was for many years employed by Cammell, Laird & Company, Limited. Leaving their employ some thirteen years ago, he founded the firm of William McLean, Limited, iron and steel merchants, of Stirling Chambers, Campo Lane, Sheffield.

Trade Talk.

DARWEN & MILNER, LIMITED, of Sheffield, have purchased the works of the Sheffield Simplex Company at Tinsley.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, have removed their Cardiff offices to 26 and 27, St. Mary Street, Cardiff.

WILLIAM GRAY & COMPANY, LIMITED, who hitherto have rented the Wear Shipyard at Sunderland, have now purchased it outright.

CONSIDERABLE DAMAGE was caused by an outbreak of fire which occurred last week at the works of John Spencer, Limited, Globe Tube Works, Wednesbury.

THE UNDERFEED STOKER COMPANY, LIMITED, have recently taken orders for 16 travelling grate stokers, 18 Underfeed stokers, three air heaters, three suspended arches, and nine ash conveyors.

MR. F. DUDLEY HENSON has acquired the business of Thomas Gibson & Sons, iron and brass founders, Broad Street Works, Stamford, and will continue it under the style of Thomas Gibson & Sons.

THE CLEVELAND BRIDGE AND ENGINEERING COMPANY, LIMITED, have been awarded the contract for the construction of the new viaduct over the River Wansbeck at North Seaton. The scheme will involve about 1,750 tons of steelwork.

THE MUNICIPALITY OF COPENHAGEN have placed another large order for water-tube boilers with the Vickers Spearing Boiler Company, Barrow-in-Furness. This is the second contract the municipality has placed with this company recently.

LICENCES UNDER THE NON-FERROUS METAL INDUSTRY ACT, 1918, have been granted by the Board of Trade to Dawson Partners, Limited, 12, Coleman Street, London, E.C., and the Sheet Iron Workers, Limited, Cradley, near Cradley Heath, Staffs.

THE GLASGOW TOWN COUNCIL have given consideration to a proposal to place a contract for tramway track work with an American firm. The subject arose from the minutes of the Tramways Committee, which recommended that the estimate of £7,850 of the United States Steel Products Company, Limited, be accepted, an amendment favouring the acceptance of the lowest British offer—£8,660 by the Titan Track Work Co., Limited—being defeated by the casting vote of the chairman of the sub-committee making the recommendation. The Town Council reversed this decision, and decided to order the English rails.

TANKS & DRUMS, LIMITED, Bowling Iron Works, Bradford, are extending their works to cope with the increased demand for their products. The concern began in the Shipley district, and were formerly known as the Shipley Tank Company, Limited. The rapid development brought about their removal eleven years ago to Bowling, Bradford, where they have siding accommodation and up-to-date works with room for extensions. The management and staff occupy the offices of the old Bowling Iron Company. For many years the business was controlled and managed by the late Mr. D. H. Thornton, who was formerly chairman of Thornton, Hannam & Marshall, Limited, now part of the Bradford Dyers' Association, Limited, of which Mr. Thornton was also a director. Upon Mr. Thornton's death his son, Major W. H. Thornton, succeeded to the position of managing director.

THE BRITISH COPPER MANUFACTURERS, LIMITED, have been formed to acquire the businesses of Vivian & Sons, and Williams, Foster & Company, and Pascoe Grenfell & Sons. By the purchase of the business of Williams, Foster & Company and Pascoe Grenfell & Sons, the new company also acquires the whole share capital of Grice, Grice & Son, of Birmingham, manufacturers of brass and copper tubes. The authorised capital of the new company is £1,500,000 in 1,000,000 ordinary shares and 500,000 six per cent. cumulative preference shares of £1 each, of which 800,000 ordinary shares and 400,000 preference shares are being issued on formation. Each of the vendor companies take the whole of its consideration in shares of the new company. The fusion terms secure to the new company adequate working capital and sufficient cash resources to enable it to proceed with its immediate development programme and the scheme of reorganisation now in contemplation. The following directors of the amalgamated companies will join the board of the new company: Sir R. Sothern Holland (chairman); E. E. Dendy, C.B.E., Lieut.-Colonel J. H. M. Greenly, M. W. Henty, Captain Hugh Vivian (these four gentlemen being joint managing directors); J. E. Budd, Major the Hon. U. Colborne, F. Heim, the Lord Swansea, and Vice-Admiral A. Walker-Heneage-Vivian.

MR. HOLLINWORTH'S ILLNESS.—We regret to announce that up to the time of going to press no change in the patient's condition was reported.

Company News.

Platt Brothers & Company, Limited.—Interim dividend, 2½ per cent., less tax, on ordinary shares.

J. & H. Allday, Limited, 16, Berners Street, Oxford Street, London, W.1.—Capital £2,000 in £1 shares. Dealers in iron.

Harris & Field, Limited, Protector Foundry, Tipton, Staffs.—Capital £100 in £1 shares. Founders, iron, steel, metal and general merchants, etc.

Drake & Gorham, Limited.—Net profit, £3,842, converting debit brought forward into credit of £3,783; general reserve, £3,500; carried forward, £283.

Thomas Ball & Company, Limited, Cross Stamping Works, Darlaston.—Capital £3,000 in £1 shares. Stampers, piercers, press and wire workers, etc.

Hockley Plate and Metal Company, Limited, 172, Hockley Hill, Birmingham.—Capital £2,000 in £1 shares. Directors: W. E. Whittle and J. P. Higgins.

Cargo Fleet Iron Company, Limited.—Brought forward, £202,649; profits for year, £100,940; depreciation, £50,000; debenture interest, £40,691; balance, £212,899; carried forward, £212,899.

Roberts & Pickersgill, Limited.—Capital £5,000 in £1 shares. Iron and steel manufacturers, etc. Directors: R. Pickersgill and H. Roberts, 10, Greenwood Mount, Green Road, Meanwood, Leeds.

Birmingham Aluminium Casting (1903), Company, Limited.—Profit, £13,609; brought forward, £22,723; total, £36,332; dividend, 7 per cent., free of tax, for year on ordinary; carry forward, £22,380.

Garnett & Birkin, Limited.—Capital £2,000 in £1 shares. Metal founders. Directors: H. F. Garnett, The Limes, Bramcote Road, Beeston, Notts; and J. D. Birkin, 36, Nottingham Road, Nottingham.

Dorman, Long & Company, Limited.—Preference dividend for half-year to December 31 and preferred ordinary dividend for half-year to September 30 will be payable on December 31, but no dividend on ordinary.

South Durham Steel & Iron Company, Limited.—Profit, £106,644; brought forward, £203,671; total, £310,315; interest on debenture stock, £13,500; dividend on 6 per cent. cumulative preference shares to June 30, £13,500; depreciation, £40,000; balance, £243,315; dividend, 2s. per share on ordinary shares, £35,000; dividend on 6 per cent. cumulative preference shares to September 30, £4,500; carried forward, £203,815.

Contracts Open.

Bournemouth, December 11.—Cast-iron pipes and cradles, for the Bournemouth Town Council. The borough engineer, Mr. F. P. Dolamore. (Fee, £1 1s., returnable.)

Dewsbury, December 10.—Supply and erection of retort house, etc., for the Corporation. The Engineer and Manager, Gas Works.

Epsom, December 8.—Providing, laying, excavating and jointing of about 2,829 yards of 4-in. cast-iron water main, including valves, fire hydrants, etc., for the U.D.C. The Water Engineer's Offices, East Street, Epsom.

Ilkley, December 1.—1,650 yards 6-in. diameter, 300 yards 4-in. diameter and 300 yards 3-in. diameter cast-iron pipes, in 9-ft. lengths, British standard specification, class C; also supply of 300 yards 4-in. diameter and 300 yards 3-in. diameter cast-iron pipes, in 9-ft. lengths, British standard specification, class B, for the U.D.C. Mr. J. M. Gameson, waterworks engineer, Town Hall, Ilkley.

London, E.C., December 2.—Fittings, for the Bengal Nagpur Railway Company, Limited. The Company's Offices, 132, Gresham House, Old Broad Street, London, E.C.2. (Fee, 20s., non-returnable.)

London, E.C., December 3.—(a) Eastern Hospital extension—installation of two independent hot-water boilers; (b) Darenth Training Colony—installation of forced circulation hot-water supply apparatus; (c) Colindale Hospital—(1) installation of new fuel economiser, (3) new steam and feed mains, etc.; (d) St. Anne's Home—installation of heating apparatus, for the Metropolitan Asylums Board. The Office of the Board, Victoria Embankment, E.C.4. (Fee, £1, returnable.)

London, S.W., December 2.—Fourteen 150-ft. clear through spans, approximate weight 1,920 tons, for the Madras and Southern Mahratta Railway Company, Limited. The Offices of the Company, 25, Buckingham Palace Road, Westminster, S.W.1. (Fee, £1 1s., non-returnable.)

Watsons (Metallurgists), Limited, of Lancaster Street, Sheffield, report the sale of a 5-cwt. Watson rotating brass-melting furnace to one of the largest works in Spain. It is the first one to go out to Spain.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The recent revival of active buying in the Cleveland iron market, although fairly well maintained, is hardly on such a heavy scale, and some temporary weakness was to be noted consequent upon the satisfaction of home consumers' requirements for the time being. Makers of foundry pig, however, are in a more confident mood at the moment, Scotland especially being a consistent buyer, while a more favourable outlook in the export trade is also an important factor to be considered in relation to the present steadiness in current quotations. It is reported that a considerable business has been done with Continental buyers of late, and though there were but few large parcels involved, business in comparatively small lots is coming forward in an encouraging measure. If this is maintained, the prospects of an increased production in Cleveland should not be very remote. Prices consequently remain firm, with No. 3 G.M.B. at 82s., No. 1 86s. per ton, No. 4 foundry 81s., and No. 4 forge at 80s. per ton.

Corresponding conditions to those outlined above also characterise the hematite trade, the improvement recently noted in regard both to home and export business being well maintained, and last week there was a certain amount of inquiry from America. But whether this will materialise remains to be seen. Quotations are somewhat irregular. For East Coast mixed numbers 88s. 6d. per ton is a general quotation, but while in some quarters this can be shaded, in others makers are holding out for 89s. per ton. The No. 1 quality is at a premium of 6d. per ton. In the West Coast area, Bessemer mixed numbers are still quoted at 100s. per ton, delivered at Glasgow, 102s. 6d. per ton at Sheffield, and 110s. per ton at Birmingham.

LANCASHIRE.—Business in the local pig-iron market at present may be characterised as steady, with perhaps an improving outlook, due to increasing activity in the textile industry. At the moment, however, the iron consuming trades are by no means brisk, and it can hardly be anticipated that any extensive buying on the part of foundrymen will materialise until after the turn of the year. Meanwhile the usual price asked in Manchester for No. 3 Derbyshire foundry is 90s. per ton delivered, and it may be doubted whether any of this make of iron can now be bought for less; but there are other qualities, notably Northamptonshire, which are offered here at less than 90s. per ton.

THE MIDLANDS.—In South Staffordshire there is a moderate volume of business moving in foundry grades, and current orders are better. The ruling quotations at Birmingham are as follow:—Derbyshire No. 3 foundry, 82s. 6d.; Staffordshire No. 3 foundry, 85s.; Northants No. 3 foundry, 76s.

SCOTLAND.—It is satisfactory to note that negotiations have been resumed with the object of bringing about a settlement of the wages dispute in the Scottish light castings industry, which has now been in progress for about six months, and hopes are expressed that an amicable settlement can be arranged. The pig-iron market in the meantime continues steady without change in prices, No. 3 foundry quality being still quoted at 90s. per ton furnace.

Finished Iron.

Marked bar makers report rather better conditions recently, their bookings having been added to by material required for railway purposes, amongst other things. In addition, merchants have been filling up gaps in stocks. Crown bar producers have found their customers disposed to buy slightly larger quantities, but there is still no great breadth of demand such as is necessary to afford normal employment, and there seems little prospect as yet of more mills being restarted. The same familiar reasons are still given in explanation—the inadequacy of demand and the excessive cost of production. The pressure of foreign competition in commoner bars seems to have been relieved a little, but it is still sufficient, either directly or indirectly, to prevent the mills from being well occupied. Both home and export trade are poor. There is still a moderate turnover of gas strip, but not sufficient to bring into operation mills which formerly produced large quantities. Quotations:—Marked bars, £15 (net f.o.t. makers' works); crown bars, £12 15s.; common bars, £11 15s.; gas strip, £13 to £13 5s., all net delivered Birmingham area.

Steel.

The long-continued depression in the steel industry appears to be lightening to some extent, Sheffield manufacturers reporting a better state of things, and important orders coming to hand, which suggest that the stagnation in the local trades may be giving way at last. In the market for semi-products the reduction recently made in billet prices has had a beneficial effect on the volume of business. Users appear to have come to the conclusion that this is a suitable time to place contracts, and something like activity prevails. The impression is held that quotations for both basic and acid billets may not continue long at their present level. There was a Steel Association meeting recently, when prices of sections, joists and plates were considered, but it was deemed inadvisable at this juncture to advance the prices.

Scrap.

The recent improvement in markets for raw material is hardly reflected in the case of scrap metal, which remains in limited demand in most centres of the trade. Lancashire dealers continue to quote 80s. per ton delivered for good lots of broken machinery metal, and, of course, some sales are taking place; but there is no life in the market, and rumours are current that, although 80s. is the price, it is possible for the consumer to buy at less. Probably there is too much cast scrap on the market, for the consumption of it has been rather restricted all through the year, without any corresponding reduction in the supply. Strong dealers are probably able to hold back, but there are always some weak holders who are obliged to sell for what they can get.

Metals.

Copper.—Movements in the market for warrant copper of late have evidenced a steady tendency of values; the turnover has been on a heavy scale, with fluctuations mostly confined within comparatively narrow limits. The outcome of the American Presidential election failed to make any impression on sentiment, when forward copper fell considerably, but has since improved. While the world consumption of copper is generally considered quite good and at well above the pre-war period in most countries, London as a speculative centre is prejudiced by the continuance of heavy stocks. Current quotations:—*Cash*: Thursday, £63 5s.; Friday, £63 2s. 6d.; Monday, £63 7s. 6d.; Tuesday, £63 10s.; Wednesday, £63 10s.

Three Months: Thursday, £64 6s.; Friday, £64 2s. 6d.; Monday, £64 7s. 6d.; Tuesday, £64 12s. 6d.; Wednesday, £64 15s.

Tin.—As had been expected, the disclosure of last month's statistical returns, the market for standard tin has retained a bullish tendency, although without sensational developments in quotations. On the other hand, the American figures were somewhat under expectations at 5,090 tons, while the home deliveries turned out quite good, totalling 2,000 tons, the outgoings on the Continent totalling 1,546 tons. The fact has to be noted that the proportion of the Straits shipments for this country is again small, while the stocks and afloats for America, representing about 8,400 tons, are about 1,000 tons less than a month ago. Current quotations:—*Cash*: Thursday, £255 2s. 6d.; Friday, £257 10s.; Monday, £257 7s. 6d.; Tuesday, £255 5s.; Wednesday, £257.

Three Months: Thursday, £258 12s. 6d.; Friday, £260 15s.; Monday, £260 7s. 6d.; Tuesday, £258 5s.; Wednesday, £259 15s.

Spelter.—Although home demand for this metal has slackened off of late, values have persistently advanced for both near and forward. The movement is attributed to the improved conditions abroad, Germany in particular making substantial purchases. Undoubtedly consumption on the Continent is forging ahead, while the metal is only being sparingly offered by the Belgian smelters. Current quotations:—*Ordinary*: Thursday, £34 16s. 3d.; Friday, £34 13s. 9d.; Monday, £34 16s. 3d.; Tuesday, £34 17s. 6d.; Wednesday, £35 2s. 6d.

Lead.—The market for soft foreign pig continues steady, the advance in values recently noted being fairly well maintained. The position of prompt lead after being at one time rather acute, due to covering purchases, eased considerably, but the backwardation again increased to £2 per ton on a few inquiries. Arrivals during October were light, being only about 15,000 tons, but in view of the slightly curtailed demand, an adjustment in prices is now to be expected. Current quotations:—*Soft foreign (prompt)*: Thursday, £38 15s.; Friday, £39 2s. 6d.; Monday, £40; Tuesday, £40 5s.; Wednesday, £40 10s.